FIG. 1

HEADER INFORMATION (SECTION DEFINITION ETC.)	
TOTAL NODE NUMBER N	
NODE NUMBER 1	
NODE ATTRIBUTE INFORMATION OF NODE 1	
LONGITUDE OF NODE 1	LATITUDE OF NODE 1
TOTAL NUMBER OF NODES CONNECTED TO NODE 1	
CONNECTION NODE NUMBER #1	LINK NUMBER #1-1
⋮	
CONNECTION NODE NUMBER #m	LINK NUMBER #1-m
⋮ ⋮	
NODE NUMBER N	
NODE ATTRIBUTE INFORMATION OF NODE N	
LONGITUDE OF NODE N	LATITUDE OF NODE N
TOTAL NUMBER OF NODES CONNECTED TO NODE N	
CONNECTION NODE NUMBER #1	LINK NUMBER #N-1
⋮	
CONNECTION NODE NUMBER #m	LINK NUMBER #N-m
TOTAL LINK NUMBER L	
LINK NUMBER 1	
ROAD ATTRIBUTE INFORMATION OF LINK 1	
TOTAL STRUCTURAL INTERPOLATION POINT NUMBER OF LINK 1	
LONGITUDE OF INTERPOLATION POINT 1-1	LATITUDE OF INTERPOLATION POINT 1-1
⋮	
LONGITUDE OF INTERPOLATION POINT 1-p	LATITUDE OF INTERPOLATION POINT 1-p
⋮ ⋮	
LINK NUMBER L	
ROAD ATTRIBUTE INFORMATION OF LINK L	
TOTAL STRUCTURAL INTERPOLATION POINT NUMBER OF LINK L	
LONGITUDE OF INTERPOLATION POINT L-1	LATITUDE OF INTERPOLATION POINT L-1
⋮	
LONGITUDE OF INTERPOLATION POINT L-p	LATITUDE OF INTERPOLATION POINT L-p

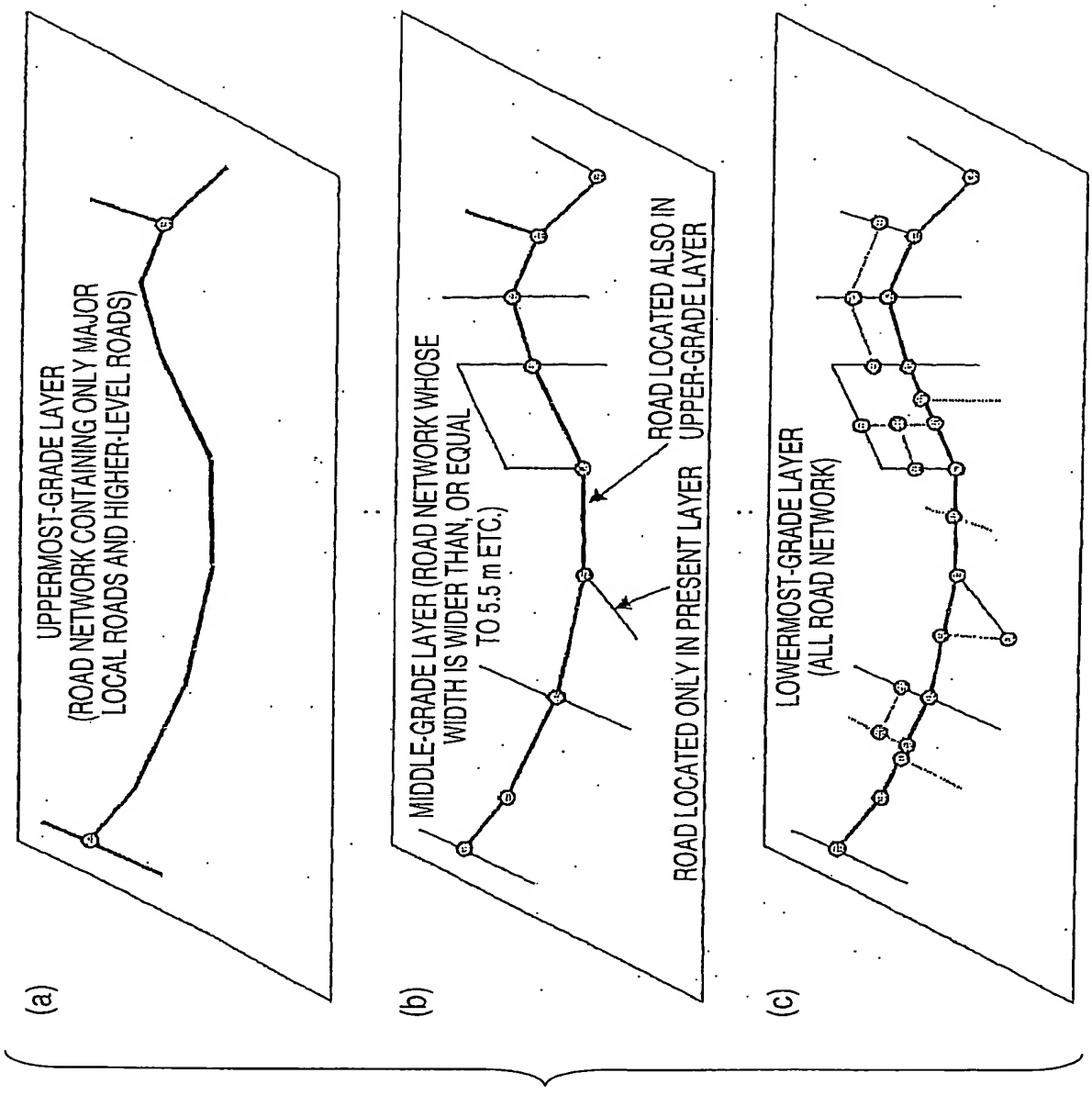

(a)
UPPERMOST-GRADE LAYER
(ROAD NETWORK CONTAINING ONLY MAJOR
LOCAL ROADS AND HIGHER-LEVEL ROADS)
(b)
MIDDLE-GRADE LAYER (ROAD NETWORK WHOSE
WIDTH IS WIDER THAN, OR EQUAL
TO 5.5 m ETC.)
ROAD LOCATED ALSO IN
UPPER-GRADE LAYER
ROAD LOCATED ONLY IN PRESENT LAYER
(c)
LOWERMOST-GRADE LAYER
(ALL ROAD NETWORK)

FIG. 2

FIG. 3

(a) UPPER-GRADE ROAD NETWORK DATA

HEADER INFORMATION (HIERARCHICAL NUMBER/SECTION DEFINITION ETC.)
TOTAL NODE NUMBER N1
NODE NUMBER 1
NODE ATTRIBUTE INFORMATION OF NODE 1
LATITUDE OF NODE 1 / LONGITUDE OF NODE 1
TOTAL NUMBER OF NODES CONNECTED TO NODE 1
CONNECTION NODE NUMBER #J1 / LINK NUMBER #J1-1
⋮
CONNECTION NODE NUMBER #Jm / LINK NUMBER #J1-m
⋮ ⋮
NODE NUMBER S
NODE ATTRIBUTE INFORMATION OF NODE S
LONGITUDE OF NODE S / LATITUDE OF NODE S
TOTAL NUMBER OF NODES CONNECTED TO NODE S (=1)
CONNECTION NODE NUMBER #J1 / LINK NUMBER #SJ1
⋮ ⋮
TOTAL LINK NUMBER L1
LINK NUMBER A
ROAD ATTRIBUTE INFORMATION OF LINK A
TOTAL STRUCTURAL INTERPOLATION POINT NUMBER OF LINK A
LONGITUDE OF INTERPOLATION POINT A-1 / LATITUDE OF INTERPOLATION POINT A-1
⋮
LONGITUDE OF INTERPOLATION POINT A-p / LATITUDE OF INTERPOLATION POINT A-p
⋮ ⋮
LINK NUMBER SJ1
ROAD ATTRIBUTE INFORMATION OF LINK SJ1
TOTAL STRUCTURAL INTERPOLATION POINT NUMBER OF LINK SJ1
LONGITUDE OF INTERPOLATION POINT 1 / LATITUDE OF INTERPOLATION POINT 1
⋮
LONGITUDE OF INTERPOLATION POINT p / LATITUDE OF INTERPOLATION POINT p
⋮ ⋮

(CONT.)

(FIG. 3 CONTINUED)

(b) MIDDLE-GRADE ROAD NETWORK DATA

HEADER INFORMATION (HIERARCHICAL NUMBER/SECTION DEFINITION ETC.)	
TOTAL NODE NUMBER N2	
NODE NUMBER 1	
NODE ATTRIBUTE INFORMATION OF NODE 1	
LATITUDE OF NODE 1	LONGITUDE OF NODE 1
TOTAL NUMBER OF NODES CONNECTED TO NODE 1	
CONNECTION NODE NUMBER #K1	LINK NUMBER #K1-1
⋮	
CONNECTION NODE NUMBER #Km	LINK NUMBER #K1-m
⋮ ⋮	
NODE NUMBER S	
NODE ATTRIBUTE INFORMATION OF NODE S	
LONGITUDE OF NODE S	LATITUDE OF NODE S
TOTAL NUMBER OF NODES CONNECTED TO NODE S (=2)	
CONNECTION NODE NUMBER #K1	LINK NUMBER #SK1
CONNECTION NODE NUMBER #K2	LINK NUMBER #SK2
⋮ ⋮	
TOTAL LINK NUMBER L2	
LINK NUMBER B	
ROAD ATTRIBUTE INFORMATION OF LINK B	
TOTAL STRUCTURAL INTERPOLATION POINT NUMBER OF LINK B	
LONGITUDE OF INTERPOLATION POINT B-1	LATITUDE OF INTERPOLATION POINT B-1
⋮	
LONGITUDE OF INTERPOLATION POINT B-p	LATITUDE OF INTERPOLATION POINT B-p
⋮ ⋮	
LINK NUMBER SK2	
ROAD ATTRIBUTE INFORMATION OF LINK SK2	
TOTAL STRUCTURAL INTERPOLATION POINT NUMBER OF LINK SK2	
LONGITUDE OF INTERPOLATION POINT 1	LATITUDE OF INTERPOLATION POINT 1
⋮	
LONGITUDE OF INTERPOLATION POINT q	LATITUDE OF INTERPOLATION POINT q
⋮ ⋮	

(CONT.)

(c) LOWER-GRADE ROAD NETWORK DATA

HEADER INFORMATION (HIERARCHICAL NUMBER/SECTION DEFINITION ETC.)	
TOTAL NODE NUMBER N3	
NODE NUMBER 1	
NODE ATTRIBUTE INFORMATION OF NODE 1	
LATITUDE OF NODE 1	LONGITUDE OF NODE 1
TOTAL NUMBER OF NODES CONNECTED TO NODE 1	
CONNECTION NODE NUMBER #1	LINK NUMBER #1-1
⋮	
CONNECTION NODE NUMBER #m	LINK NUMBER #1-m
⋮ ⋮	
NODE NUMBER S	
NODE ATTRIBUTE INFORMATION OF NODE S	
LONGITUDE OF NODE S	LATITUDE OF NODE S
TOTAL NUMBER OF NODES CONNECTED TO NODE S (=3)	
CONNECTION NODE NUMBER #M1	LINK NUMBER #SM1
CONNECTION NODE NUMBER #M2	LINK NUMBER #SM2
CONNECTION NODE NUMBER #M3	LINK NUMBER #SM3
⋮ ⋮	
TOTAL LINK NUMBER L3	
LINK NUMBER C	
ROAD ATTRIBUTE INFORMATION OF LINK C	
TOTAL STRUCTURAL INTERPOLATION POINT NUMBER OF LINK C	
LONGITUDE OF INTERPOLATION POINT C-1	LATITUDE OF INTERPOLATION POINT C-1
⋮	
LONGITUDE OF INTERPOLATION POINT C-p	LATITUDE OF INTERPOLATION POINT C-p
⋮ ⋮	
LINK NUMBER SM2	
ROAD ATTRIBUTE INFORMATION OF LINK SM2	
TOTAL STRUCTURAL INTERPOLATION POINT NUMBER OF LINK SM2	
LONGITUDE OF INTERPOLATION POINT 1	LATITUDE OF INTERPOLATION POINT 1
⋮	
LONGITUDE OF INTERPOLATION POINT r	LATITUDE OF INTERPOLATION POINT r
⋮ ⋮	

(FIG. 3(b) CONTINUED)

FIG. 4

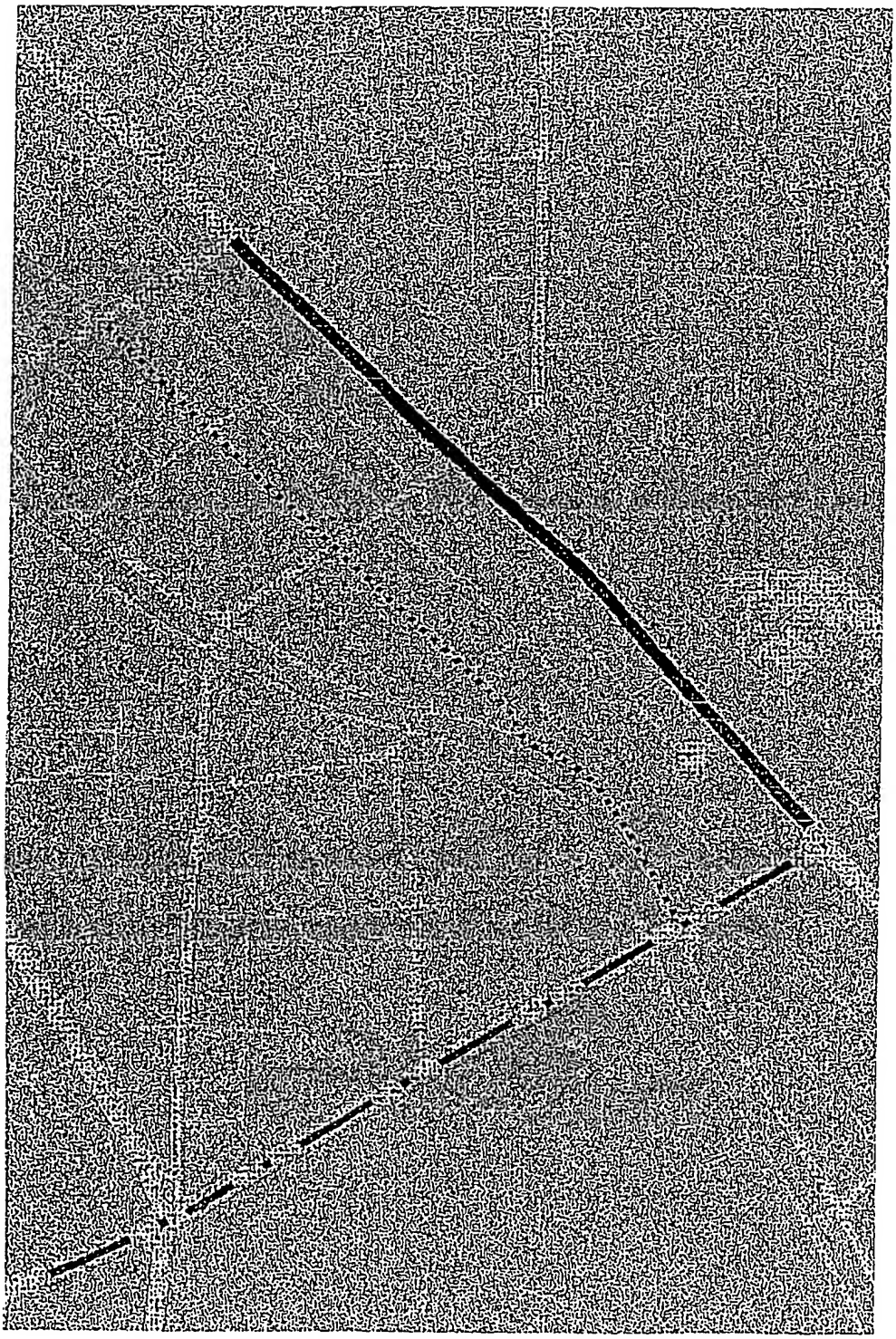


FIG. 5

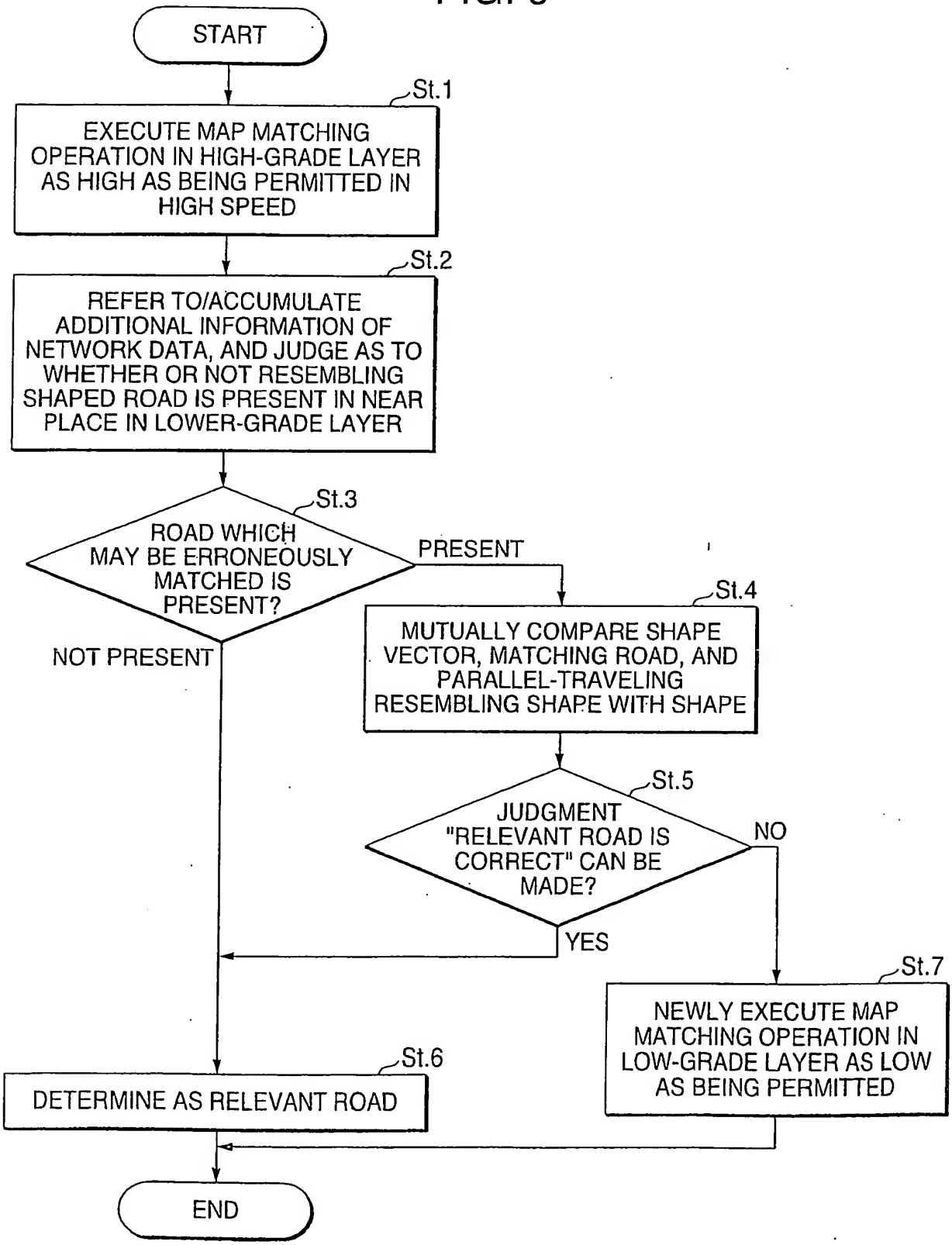

START
St.1
EXECUTE MAP MATCHING OPERATION IN HIGH-GRADE LAYER AS HIGH AS BEING PERMITTED IN HIGH SPEED
St.2
REFER TO/ACCUMULATE ADDITIONAL INFORMATION OF NETWORK DATA, AND JUDGE AS TO WHETHER OR NOT RESEMBLING SHAPED ROAD IS PRESENT IN NEAR PLACE IN LOWER-GRADE LAYER
St.3
ROAD WHICH MAY BE ERRONEOUSLY MATCHED IS PRESENT?
PRESENT
NOT PRESENT
St.4
MUTUALLY COMPARE SHAPE VECTOR, MATCHING ROAD, AND PARALLEL-TRAVELING RESEMBLING SHAPE WITH SHAPE
St.5
JUDGMENT "RELEVANT ROAD IS CORRECT" CAN BE MADE?
NO
YES
St.7
NEWLY EXECUTE MAP MATCHING OPERATION IN LOW-GRADE LAYER AS LOW AS BEING PERMITTED
St.6
DETERMINE AS RELEVANT ROAD
END

FIG. 6

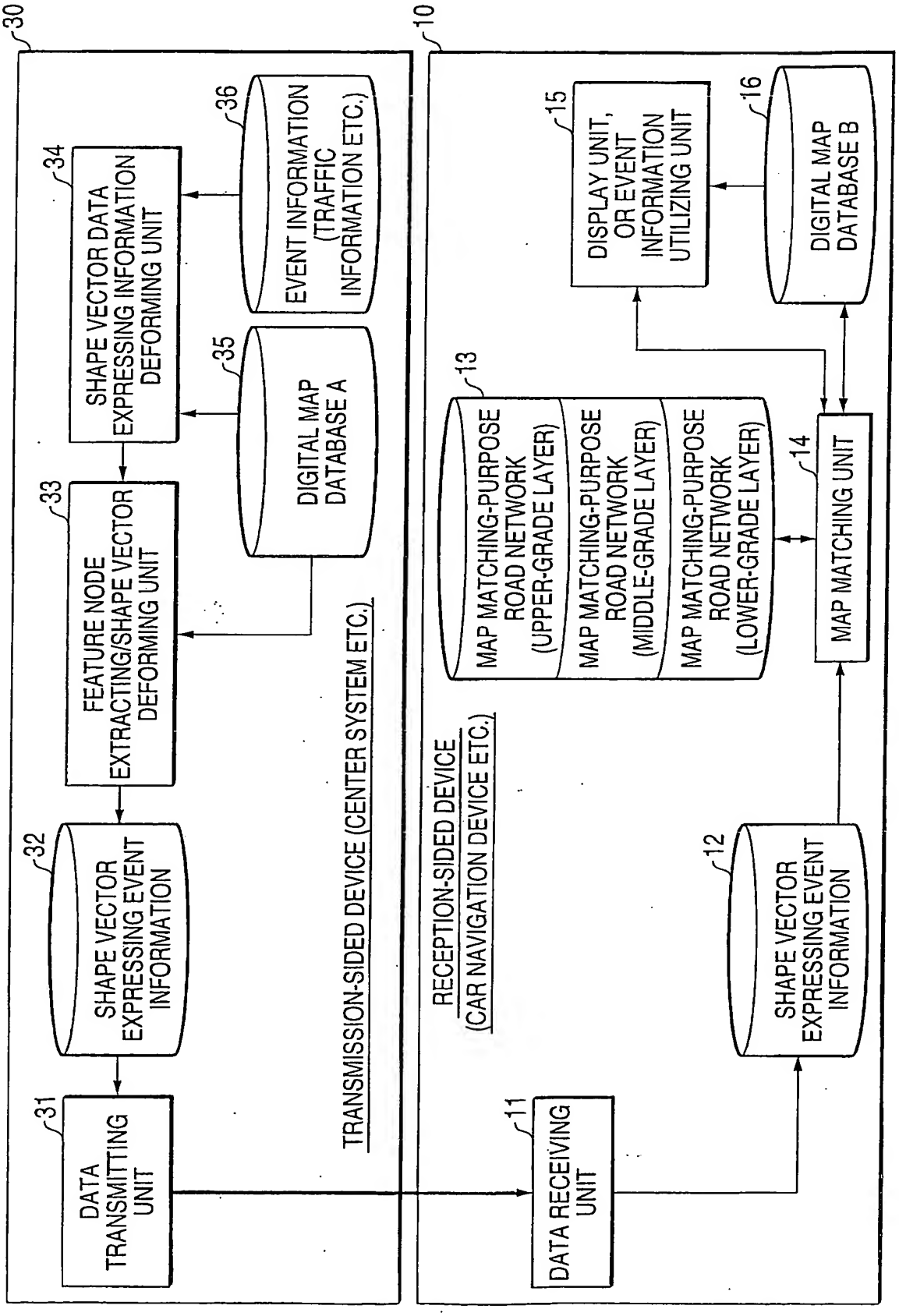

30
10
TRANSMISSION-SIDED DEVICE (CENTER SYSTEM ETC.)
RECEPTION-SIDED DEVICE
(CAR NAVIGATION DEVICE ETC.)
DATA TRANSMITTING UNIT
31
SHAPE VECTOR EXPRESSING EVENT INFORMATION
32
FEATURE NODE EXTRACTING/SHAPE VECTOR DEFORMING UNIT
33
SHAPE VECTOR DATA EXPRESSING INFORMATION DEFORMING UNIT
34
DIGITAL MAP DATABASE A
35
EVENT INFORMATION (TRAFFIC INFORMATION ETC.)
36
DATA RECEIVING UNIT
11
SHAPE VECTOR EXPRESSING EVENT INFORMATION
12
MAP MATCHING UNIT
14
MAP MATCHING-PURPOSE ROAD NETWORK (UPPER-GRADE LAYER)
MAP MATCHING-PURPOSE ROAD NETWORK (MIDDLE-GRADE LAYER)
MAP MATCHING-PURPOSE ROAD NETWORK (LOWER-GRADE LAYER)
13
DISPLAY UNIT, OR EVENT INFORMATION UTILIZING UNIT
15
DIGITAL MAP DATABASE B
16

FIG. 7

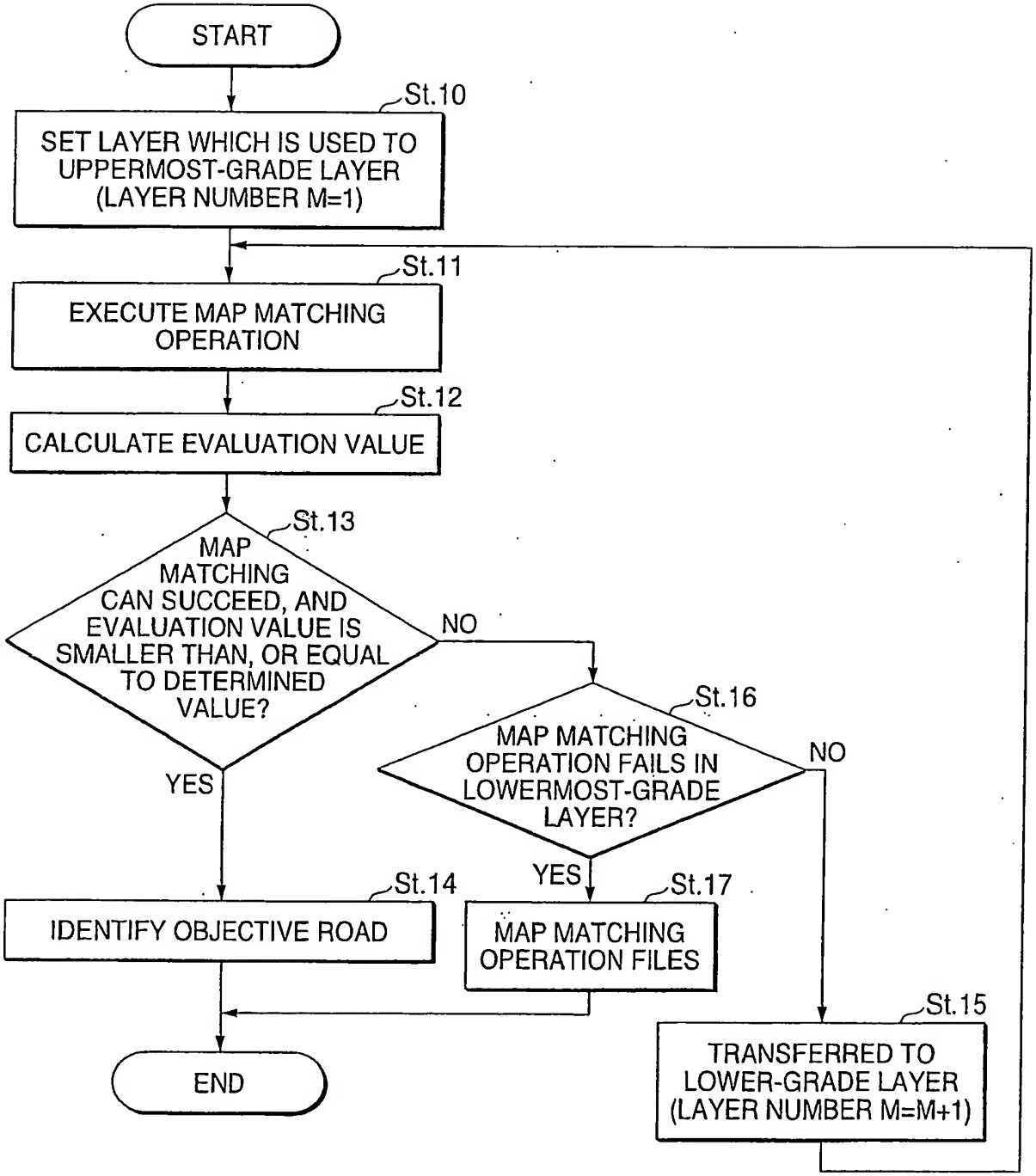

START
St.10
SET LAYER WHICH IS USED TO UPPERMOST-GRADE LAYER (LAYER NUMBER M=1)
St.11
EXECUTE MAP MATCHING OPERATION
St.12
CALCULATE EVALUATION VALUE
St.13
MAP MATCHING CAN SUCCEED, AND EVALUATION VALUE IS SMALLER THAN, OR EQUAL TO DETERMINED VALUE?
NO
YES
St.16
MAP MATCHING OPERATION FAILS IN LOWERMOST-GRADE LAYER?
NO
YES
St.14
IDENTIFY OBJECTIVE ROAD
St.17
MAP MATCHING OPERATION FILES
St.15
TRANSFERRED TO LOWER-GRADE LAYER (LAYER NUMBER M=M+1)
END

FIG. 8

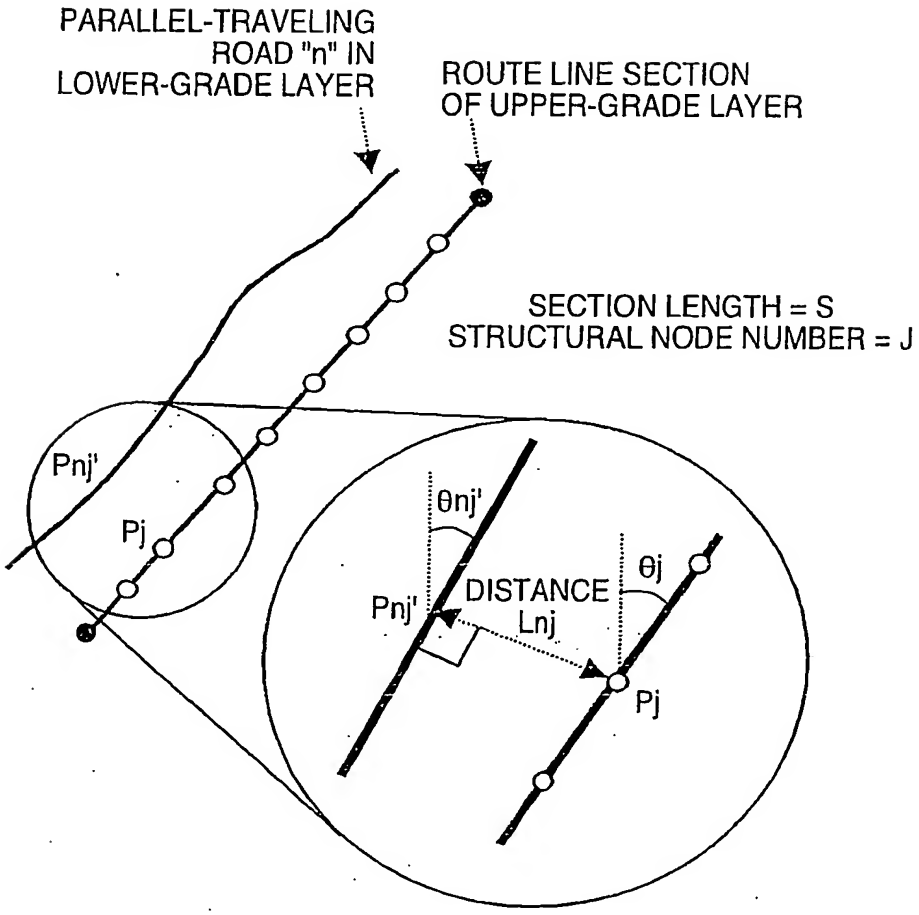

PARALLEL-TRAVELING ROAD "n" IN LOWER-GRADE LAYER
ROUTE LINE SECTION OF UPPER-GRADE LAYER
SECTION LENGTH = S
STRUCTURAL NODE NUMBER = J
Pnj'
Pj
θnj'
θj
Pnj'
DISTANCE Lnj
Pj

FIG. 9

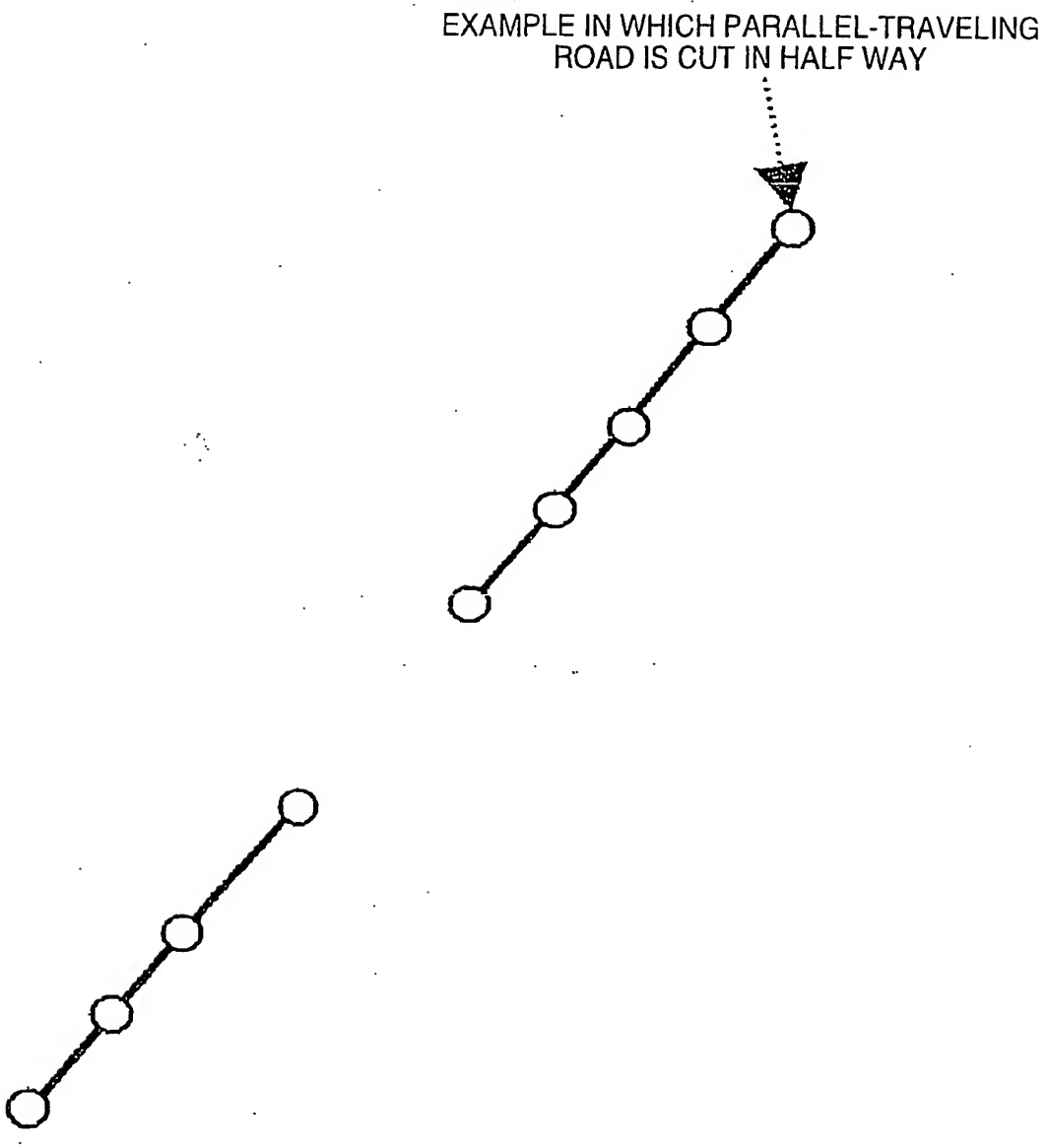


FIG. 10

EXAMPLE OF MAP MATCHING PURPOSE ROAD NETWORK DATA

(a)

HEADER INFORMATION (HIERARCHICAL NUMBER/SECTION DEFINITION ETC.)	
TOTAL NODE NUMBER N	
NODE NUMBER 1	
ATTRIBUTE INFORMATION OF NODE 1	
LONGITUDE OF NODE 1	LATITUDE OF NODE 1
TOTAL NUMBER OF NODES CONNECTED TO NODE 1	
CONNECTION NODE NUMBER #1	LINK NUMBER #1-1
⋮	
CONNECTION NODE NUMBER #m	LINK NUMBER #1-m
⋮ ⋮	
TOTAL LINK NUMBER L	
LINK NUMBER 1	
ROAD ATTRIBUTE INFORMATION OF LINK 1	
PARALLEL-TRAVELING RESEMBLING SHAPE ATTRIBUTE OF LINK 1	
TOTAL STRUCTURAL INTERPOLATION POINT NUMBER OF LINK 1	
LONGITUDE OF INTERPOLATION POINT 1-1	LATITUDE OF INTERPOLATION POINT 1-1
⋮	
LONGITUDE OF INTERPOLATION POINT 1-p	LATITUDE OF INTERPOLATION POINT 1-p
⋮ ⋮	
LINK NUMBER L	
ROAD ATTRIBUTE INFORMATION OF LINK L	
PARALLEL-TRAVELING RESEMBLING SHAPE ATTRIBUTE OF LINK L	
TOTAL STRUCTURAL INTERPOLATION POINT NUMBER OF LINK L	
LONGITUDE OF INTERPOLATION POINT L-1	LATITUDE OF INTERPOLATION POINT L-1
⋮	
LONGITUDE OF INTERPOLATION POINT L-p	LATITUDE OF INTERPOLATION POINT L-p

(CONT.)

(b)

PARALLEL-TRAVELING RESEMBLING SHAPED ROAD PRESENCE/ABSENCE INFORMATION
(IN CASE THAT ONE DIRECTION IS REPRESENTED BY 1 LINK)

PRESENCE/ABSENCE OF PARALLEL-TRAVELING RESEMBLING SHAPE (PRESENCE/PRESENCE IN PARTIAL SECTION/ABSENCE)
CONNECTION/NON-CONNECTION AT UP/DOWN-STREAM SIDED INTERSECTIONS

(FIG. 10 CONTINUED)

FIG. 11

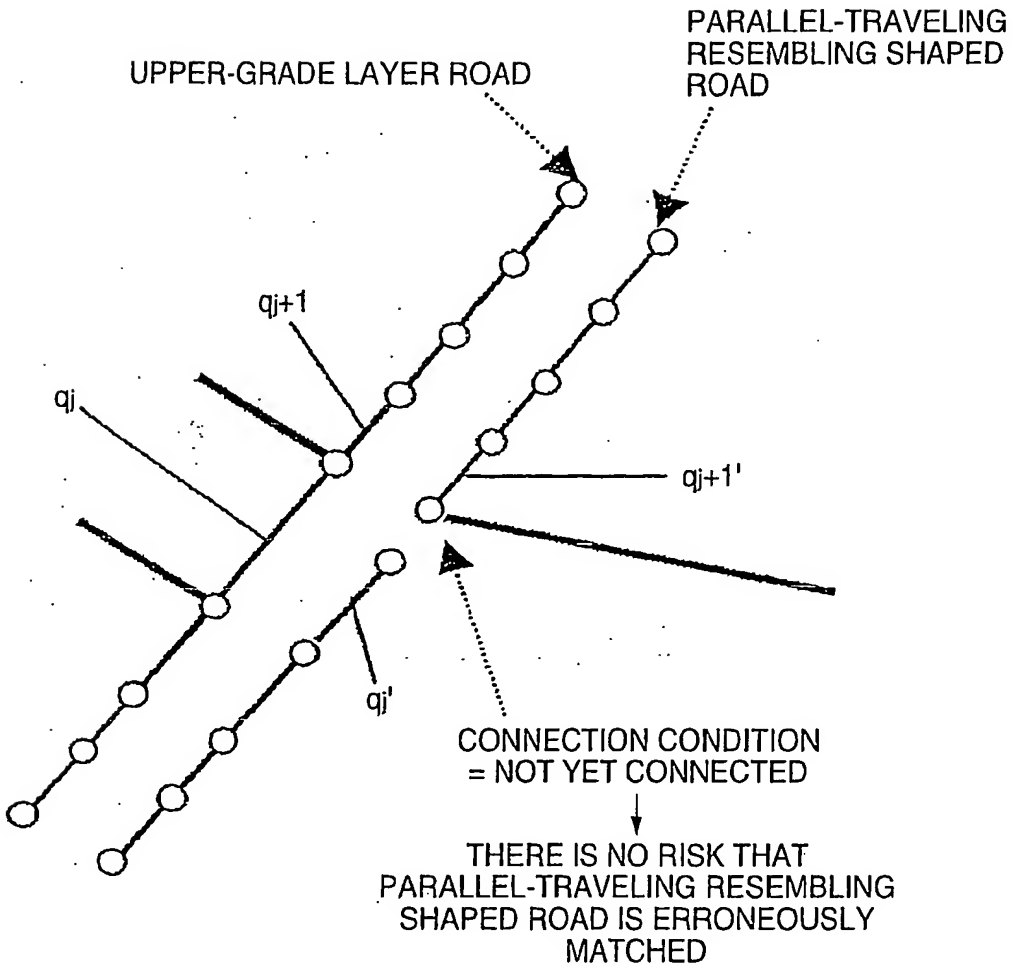

PARALLEL-TRAVELING RESEMBLING SHAPED ROAD
UPPER-GRADE LAYER ROAD
qj+1
qj
qj+1'
qj'
CONNECTION CONDITION = NOT YET CONNECTED
THERE IS NO RISK THAT PARALLEL-TRAVELING RESEMBLING SHAPED ROAD IS ERRONEOUSLY MATCHED

FIG. 12

EXAMPLE OF MAP MATCHING PURPOSE ROAD NETWORK DATA

(a)

HEADER INFORMATION (HIERARCHICAL NUMBER/SECTION DEFINITION ETC.)	
TOTAL NODE NUMBER N	
NODE NUMBER 1	
ATTRIBUTE INFORMATION OF NODE 1	
LONGITUDE OF NODE 1	LATITUDE OF NODE 1
TOTAL NUMBER OF NODES CONNECTED TO NODE 1	
CONNECTION NODE NUMBER #1	LINK NUMBER #1-1
⋮	
CONNECTION NODE NUMBER #m	LINK NUMBER #1-m
⋮ ⋮	
TOTAL LINK NUMBER L	
LINK NUMBER 1	
ROAD ATTRIBUTE INFORMATION (ROAD SOAT ETC.) OF LINK 1	
PARALLEL-TRAVELING RESEMBLING SHAPE ATTRIBUTE OF LINK 1	
TOTAL STRUCTURAL INTERPOLATION POINT NUMBER OF LINK 1	
LONGITUDE OF INTERPOLATION POINT 1-1	LATITUDE OF INTERPOLATION POINT 1-1
⋮	
LONGITUDE OF INTERPOLATION POINT 1-p	LATITUDE OF INTERPOLATION POINT 1-p
⋮ ⋮	
LINK NUMBER L	
ROAD ATTRIBUTE INFORMATION (ROAD SOAT ETC.) OF LINK L	
PARALLEL-TRAVELING CONNECTING SHAPE ATTRIBUTE OF LINK L	
TOTAL STRUCTURAL INTERPOLATION POINT OF LINK L	
LONGITUDE OF INTERPOLATION POINT L-1	LATITUDE OF INTERPOLATION POINT L-1
⋮	
LONGITUDE OF INTERPOLATION POINT L-p	LATITUDE OF INTERPOLATION POINT L-p

(CONT.)

(b)

PARALLEL-TRAVELING RESEMBLING SHAPE ATTRIBUTE INFORMATION
(IN CASE THAT ONE DIRECTION IS INDICATED BY 1 LINK)

DECLINATION ACCUMULATED VALUE OF LINK 1.		
DECLINATION ABSOLUTE VALUE ACCUMULATED VALUE OF LINK 1		
TOTAL NUMBER OF PARALLEL-TRAVELING RESEMBLING SHAPES		
RESEMBLING SHAPE EVALUATION VALUE	HIERARCHICAL LAYER	1
ROAD ATTRIBUTE	ENTIRE/PARTIAL IDENTIFY	
DECLINATION ACCUMULATED VALUE		
DECLINATION ABSOLUTE VALUE ACCUMULATED VALUE		
FLUCTUATION (STANDARD DEVIATION) WITH RESPECT TO LINK 1		
CONNECT/NOT CONNECT AT UP-STREAM SIDED INTERSECTION		
DECLINATION ABSOLUTE VALUE ACCUMULATED VALUE (MINIMUM VALUE) OF CONNECTION PORTION		
RESEMBLING SHAPE EVALUATION VALUE	HIERARCHICAL LAYER	2
ROAD ATTRIBUTE	ENTIRE/PARTIAL IDENTIFY	
DECLINATION ACCUMULATED VALUE		
DECLINATION ABSOLUTE VALUE ACCUMULATED VALUE		
FLUCTUATION (STANDARD DEVIATION) WITH RESPECT TO LINK 1		
CONNECT/NON-CONNECT FLAG TO UP-STREAM SIDED INTERSECTION		
DECLINATION ABSOLUTE VALUE ACCUMULATED VALUE (MINIMUM VALUE) OF CONNECTION PORTION		

(FIG. 12 CONTINUED)

FIG. 13

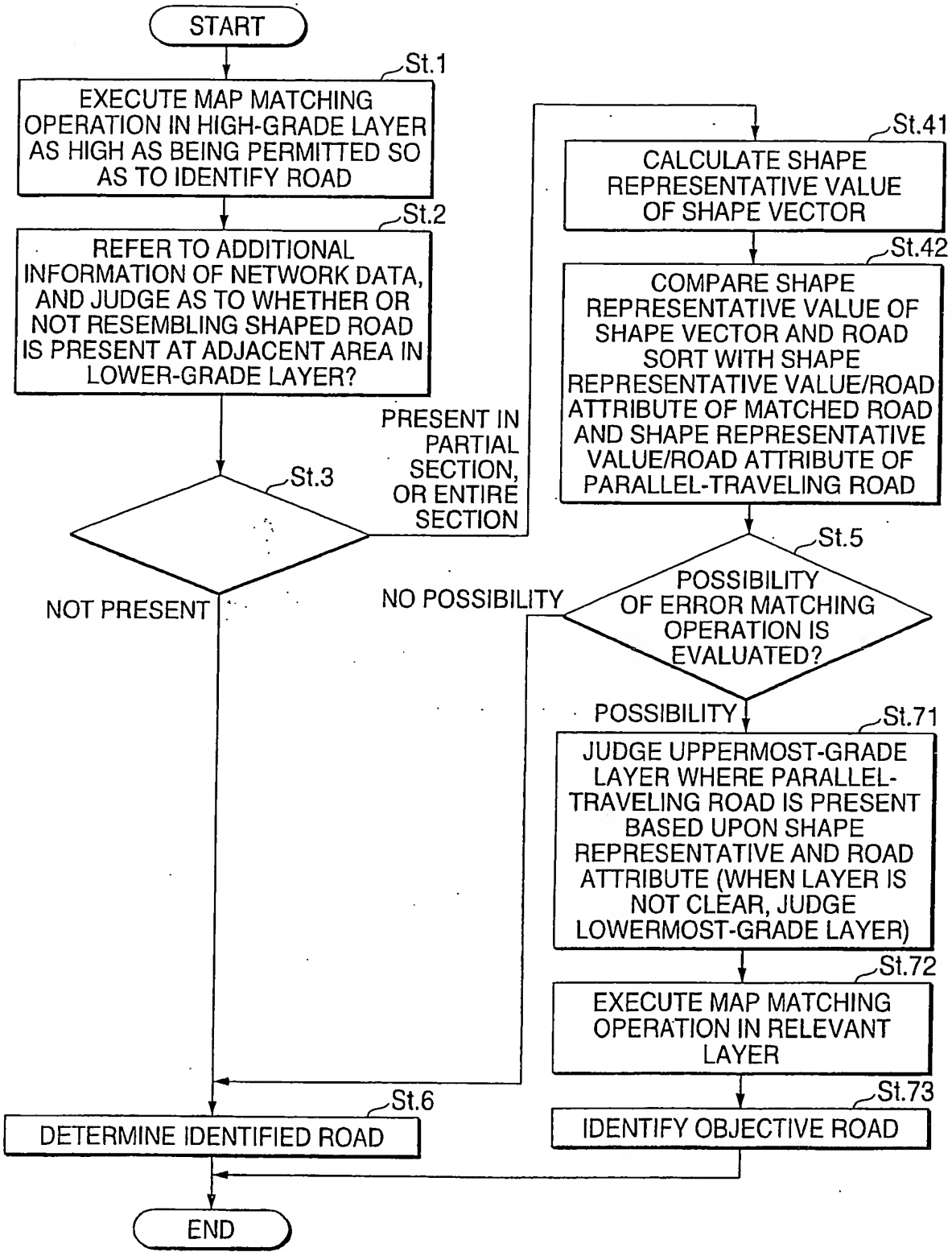

START
St.1
EXECUTE MAP MATCHING OPERATION IN HIGH-GRADE LAYER AS HIGH AS BEING PERMITTED SO AS TO IDENTIFY ROAD
St.2
REFER TO ADDITIONAL INFORMATION OF NETWORK DATA, AND JUDGE AS TO WHETHER OR NOT RESEMBLING SHAPED ROAD IS PRESENT AT ADJACENT AREA IN LOWER-GRADE LAYER?
St.3
PRESENT IN PARTIAL SECTION, OR ENTIRE SECTION
NOT PRESENT
St.41
CALCULATE SHAPE REPRESENTATIVE VALUE OF SHAPE VECTOR
St.42
COMPARE SHAPE REPRESENTATIVE VALUE OF SHAPE VECTOR AND ROAD SORT WITH SHAPE REPRESENTATIVE VALUE/ROAD ATTRIBUTE OF MATCHED ROAD AND SHAPE REPRESENTATIVE VALUE/ROAD ATTRIBUTE OF PARALLEL-TRAVELING ROAD
St.5
POSSIBILITY OF ERROR MATCHING OPERATION IS EVALUATED?
NO POSSIBILITY
POSSIBILITY
St.71
JUDGE UPPERMOST-GRADE LAYER WHERE PARALLEL-TRAVELING ROAD IS PRESENT BASED UPON SHAPE REPRESENTATIVE AND ROAD ATTRIBUTE (WHEN LAYER IS NOT CLEAR, JUDGE LOWERMOST-GRADE LAYER)
St.72
EXECUTE MAP MATCHING OPERATION IN RELEVANT LAYER
St.73
IDENTIFY OBJECTIVE ROAD
St.6
DETERMINE IDENTIFIED ROAD
END

FIG. 14

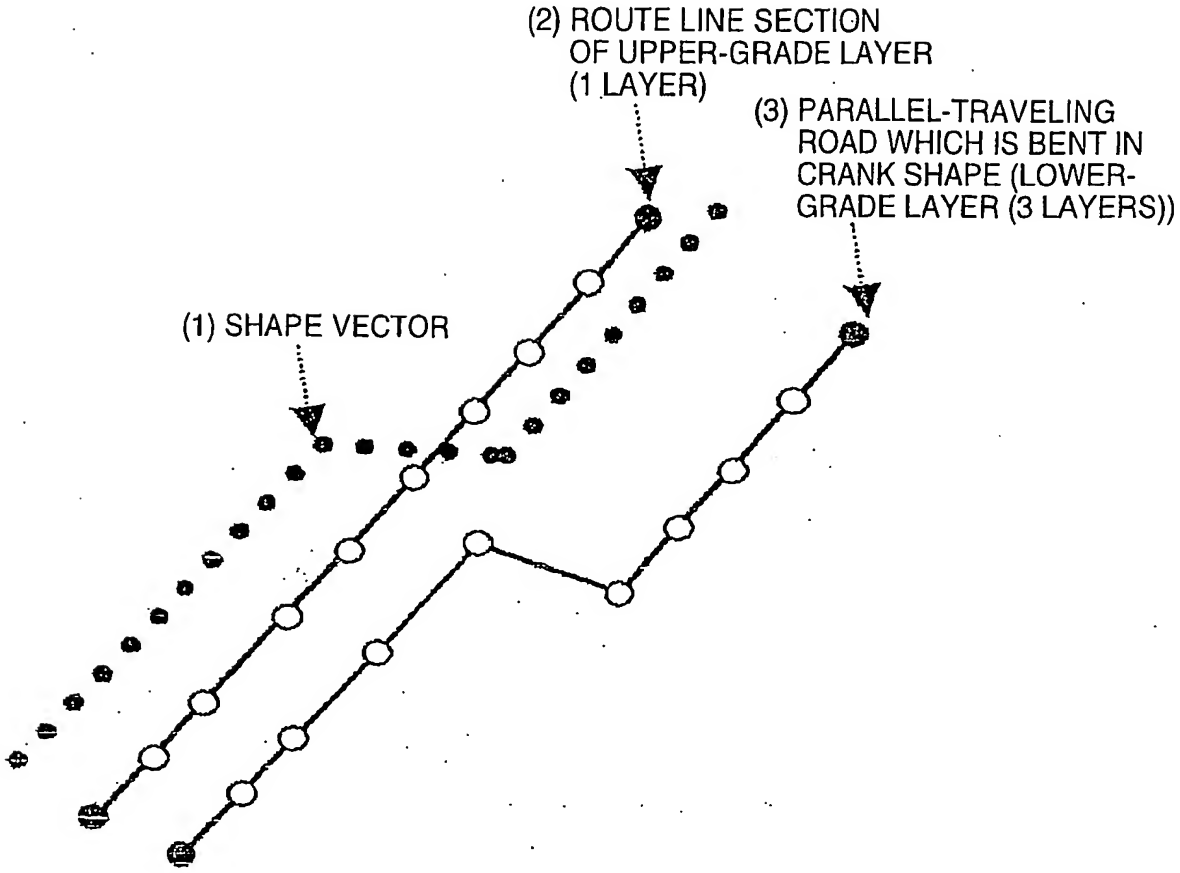
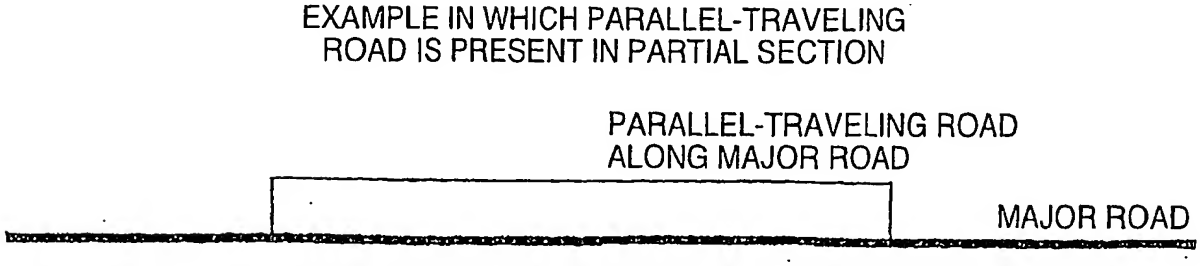

(2) ROUTE LINE SECTION OF UPPER-GRADE LAYER (1 LAYER)
(3) PARALLEL-TRAVELING ROAD WHICH IS BENT IN CRANK SHAPE (LOWER-GRADE LAYER (3 LAYERS))
(1) SHAPE VECTOR

FIG. 15


EXAMPLE IN WHICH PARALLEL-TRAVELING ROAD IS PRESENT IN PARTIAL SECTION
PARALLEL-TRAVELING ROAD ALONG MAJOR ROAD
MAJOR ROAD

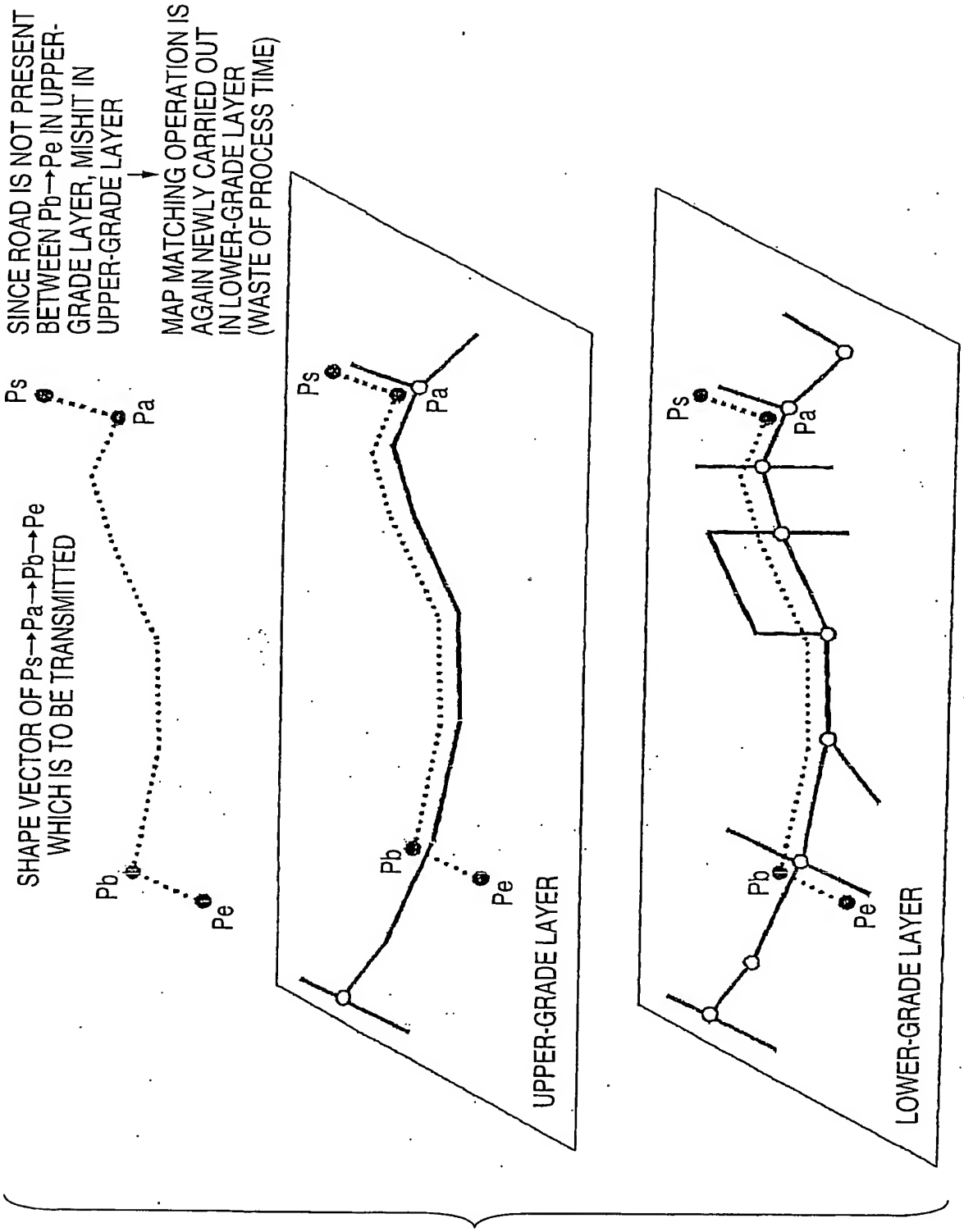

SHAPE VECTOR OF Ps→Pa→Pb→Pe WHICH IS TO BE TRANSMITTED
Ps
Pa
Pb
Pe
SINCE ROAD IS NOT PRESENT BETWEEN Pb→Pe IN UPPER-GRADE LAYER, MISHIT IN UPPER-GRADE LAYER
MAP MATCHING OPERATION IS AGAIN NEWLY CARRIED OUT IN LOWER-GRADE LAYER (WASTE OF PROCESS TIME)
UPPER-GRADE LAYER
LOWER-GRADE LAYER

FIG. 16

FIG. 17

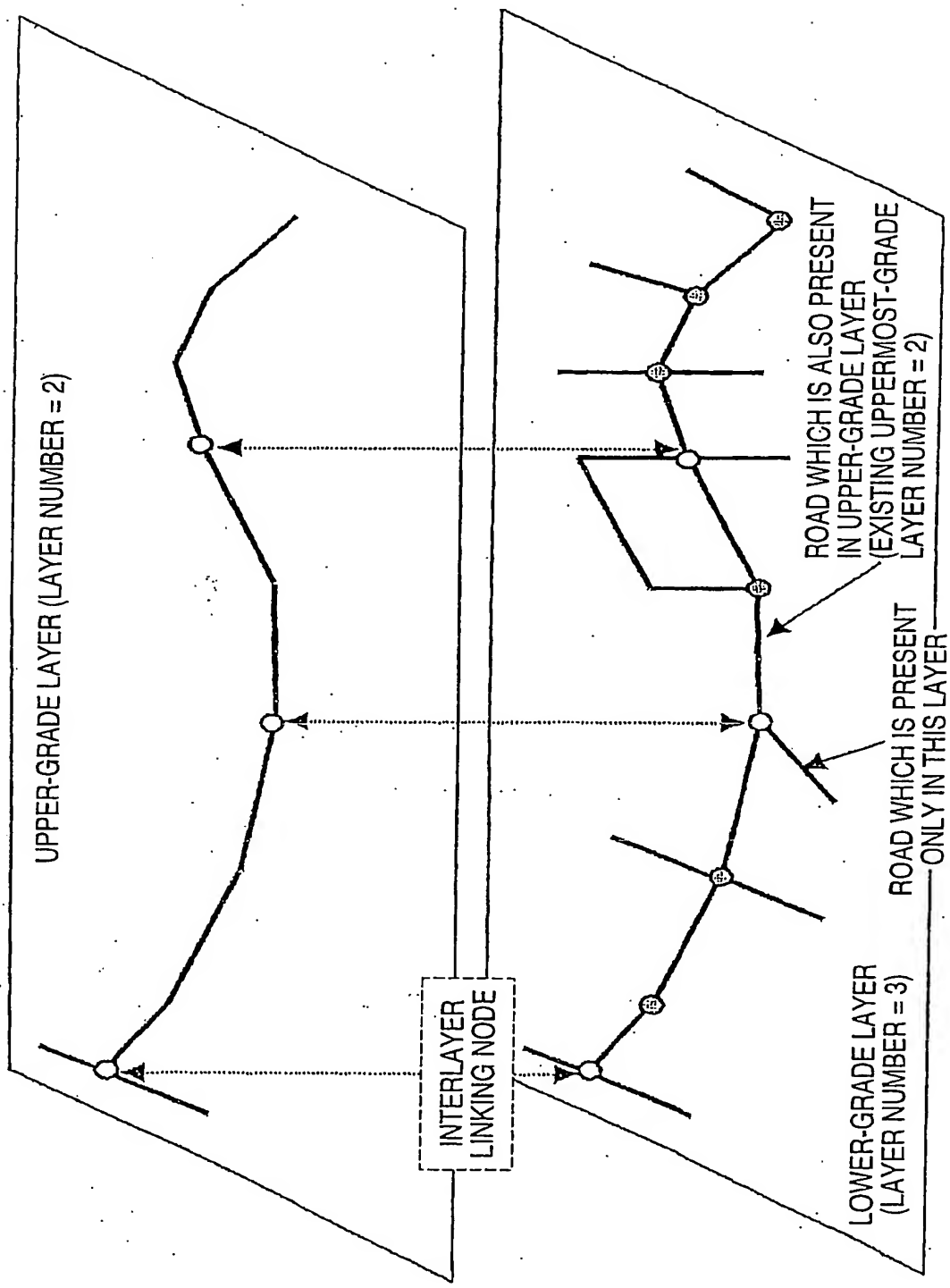

UPPER-GRADE LAYER (LAYER NUMBER = 2)
INTERLAYER LINKING NODE
ROAD WHICH IS ALSO PRESENT IN UPPER-GRADE LAYER (EXISTING UPPERMOST-GRADE LAYER NUMBER = 2)
ROAD WHICH IS PRESENT ONLY IN THIS LAYER
LOWER-GRADE LAYER (LAYER NUMBER = 3)

FIG. 18

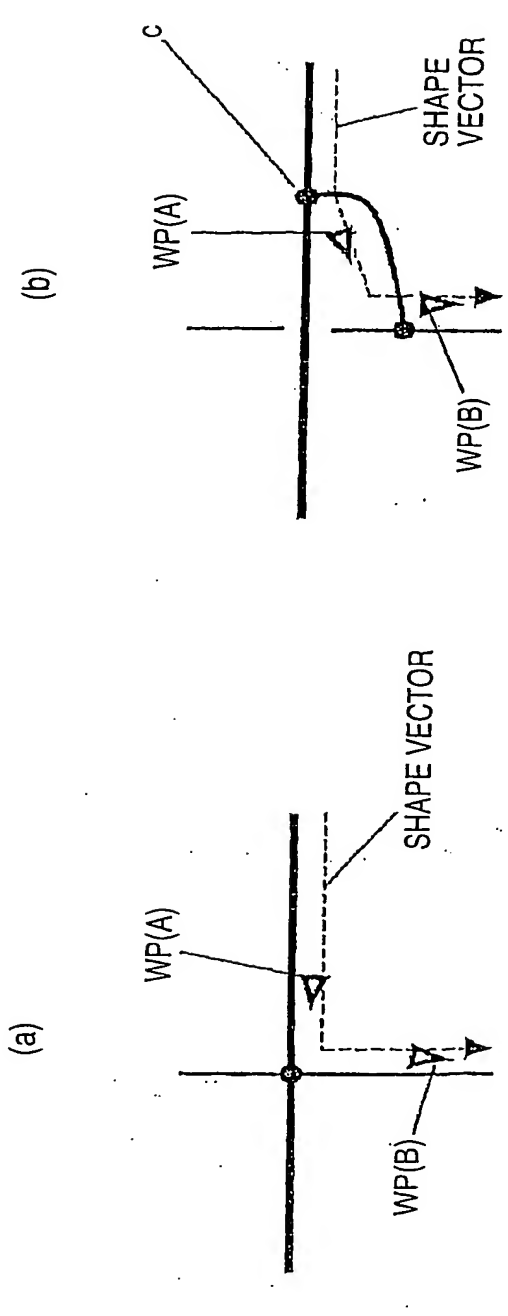


FIG. 19

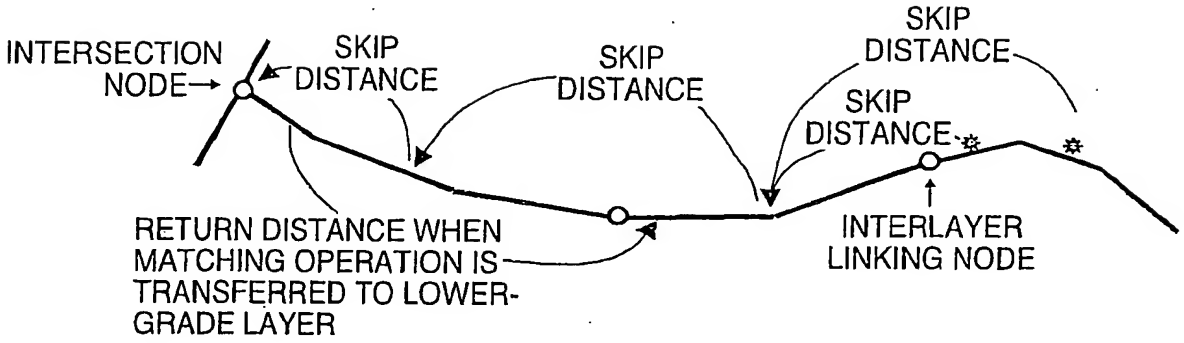

INTERSECTION NODE
SKIP DISTANCE
SKIP DISTANCE
SKIP DISTANCE
SKIP DISTANCE
RETURN DISTANCE WHEN MATCHING OPERATION IS TRANSFERRED TO LOWER-GRADE LAYER
INTERLAYER LINKING NODE

FIG. 20

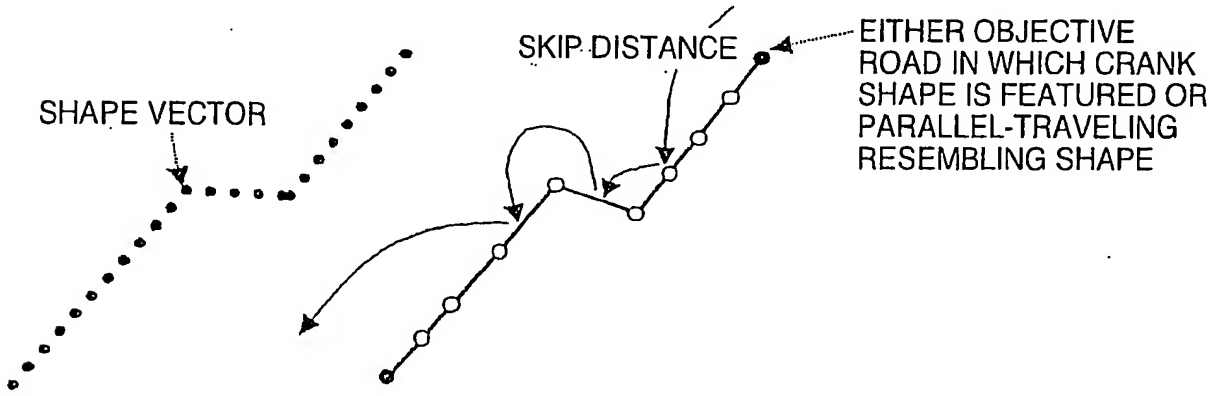

SHAPE VECTOR
SKIP DISTANCE
EITHER OBJECTIVE ROAD IN WHICH CRANK SHAPE IS FEATURED OR PARALLEL-TRAVELING RESEMBLING SHAPE

FIG. 21

HEADER INFORMATION (HIERARCHICAL NUMBER/SECTION DEFINITION ETC.)	
TOTAL NODE NUMBER N	
NODE NUMBER 1	
ATTRIBUTE INFORMATION OF NODE 1	
LONGITUDE OF NODE 1	LATITUDE OF NODE 1
TOTAL NUMBER OF NODES CONNECTED TO NODE 1	
CONNECTION NODE NUMBER #1	LINK NUMBER #1-1
⋮	
CONNECTION NODE NUMBER #m	LINK NUMBER #1-m
⋮ ⋮	
TOTAL LINK NUMBER L	
LINK NUMBER 1	
ROAD ATTRIBUTE INFORMATION OF LINK 1	
PARALLEL-TRAVELING RESEMBLING SHAPE ATTRIBUTE OF LINK 1	
UPPERMOST-GRADE LAYER NUMBER OF PRESENT ROAD	
TOTAL STRUCTURAL INTERPOLATION POINT OF LINK 1	
LONGITUDE OF INTERPOLATION POINT 1-1	LATITUDE OF INTERPOLATION POINT 1-1
RECOMMENDED SKIP DISTANCE IN LINK BETWEEN 1-1 AND 1-2	
(RETURN DISTANCE IN LINK BETWEEN 1-1 AND 1-2 WHEN MAP MATCHING OPERATION IS TRANSFERRED TO LOWER-GRADE LAYER)	
LONGITUDE OF INTERPOLATION POINT 1-2	LATITUDE OF INTERPOLATION POINT 1-2
⋮	
LONGITUDE OF INTERPOLATION POINT 1-p	LATITUDE OF INTERPOLATION POINT 1-p
⋮ ⋮	

FIG. 22

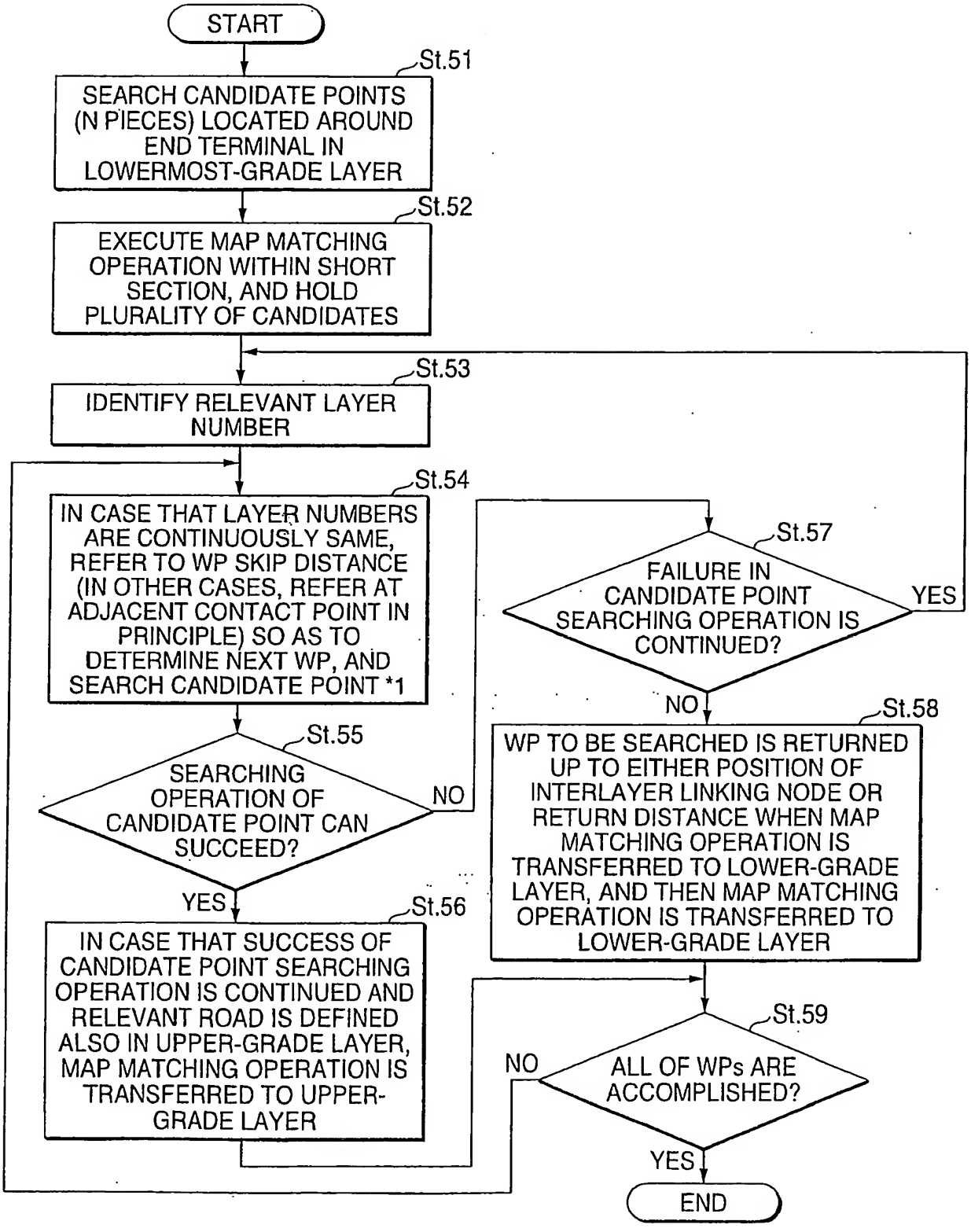

START
St.51
SEARCH CANDIDATE POINTS (N PIECES) LOCATED AROUND END TERMINAL IN LOWERMOST-GRADE LAYER
St.52
EXECUTE MAP MATCHING OPERATION WITHIN SHORT SECTION, AND HOLD PLURALITY OF CANDIDATES
St.53
IDENTIFY RELEVANT LAYER NUMBER
St.54
IN CASE THAT LAYER NUMBERS ARE CONTINUOUSLY SAME, REFER TO WP SKIP DISTANCE (IN OTHER CASES, REFER AT ADJACENT CONTACT POINT IN PRINCIPLE) SO AS TO DETERMINE NEXT WP, AND SEARCH CANDIDATE POINT *1
St.55
SEARCHING OPERATION OF CANDIDATE POINT CAN SUCCEED?
NO
YES
St.56
IN CASE THAT SUCCESS OF CANDIDATE POINT SEARCHING OPERATION IS CONTINUED AND RELEVANT ROAD IS DEFINED ALSO IN UPPER-GRADE LAYER, MAP MATCHING OPERATION IS TRANSFERRED TO UPPER-GRADE LAYER
St.57
FAILURE IN CANDIDATE POINT SEARCHING OPERATION IS CONTINUED?
YES
NO
St.58
WP TO BE SEARCHED IS RETURNED UP TO EITHER POSITION OF INTERLAYER LINKING NODE OR RETURN DISTANCE WHEN MAP MATCHING OPERATION IS TRANSFERRED TO LOWER-GRADE LAYER, AND THEN MAP MATCHING OPERATION IS TRANSFERRED TO LOWER-GRADE LAYER
St.59
ALL OF WPs ARE ACCOMPLISHED?
NO
YES
END

FIG. 23

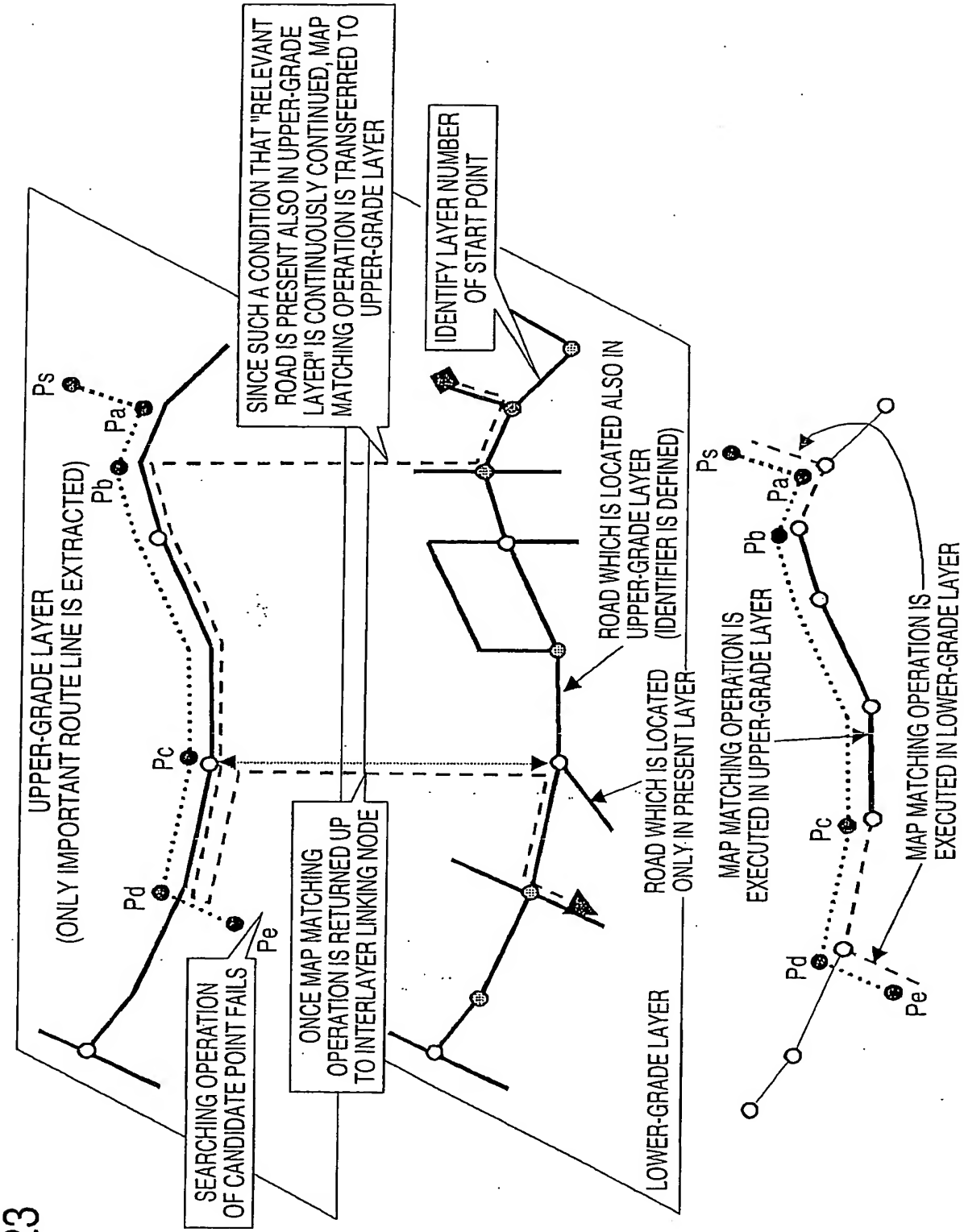

UPPER-GRADE LAYER
(ONLY IMPORTANT ROUTE LINE IS EXTRACTED)
Ps
Pa
Pb
Pc
Pd
Pe
SINCE SUCH A CONDITION THAT "RELEVANT ROAD IS PRESENT ALSO IN UPPER-GRADE LAYER" IS CONTINUOUSLY CONTINUED, MAP MATCHING OPERATION IS TRANSFERRED TO UPPER-GRADE LAYER
IDENTIFY LAYER NUMBER OF START POINT
ROAD WHICH IS LOCATED ALSO IN UPPER-GRADE LAYER (IDENTIFIER IS DEFINED)
ROAD WHICH IS LOCATED ONLY IN PRESENT LAYER
SEARCHING OPERATION OF CANDIDATE POINT FAILS
ONCE MAP MATCHING OPERATION IS RETURNED UP TO INTERLAYER LINKING NODE
LOWER-GRADE LAYER
MAP MATCHING OPERATION IS EXECUTED IN UPPER-GRADE LAYER
MAP MATCHING OPERATION IS EXECUTED IN LOWER-GRADE LAYER
Ps
Pa
Pb
Pc
Pd
Pe'

FIG. 24

SHAPE VECTOR DATA STREAM

BASE MAP PRECISION INFORMATION OF SHAPE VECTOR
SHAPE VECTOR STREAM IDENTIFICATION NUMBER = 1
ROAD ATTRIBUTE
MAXIMUM DEFORMATION AMOUNT [m] WHEN DEFORMATION IS MADE SO AS TO PREVENT ERRONEOUS MAP MATCHING OPERATION
MAXIMUM ALLOWABLE ERROR AMOUNT [m] WHEN NON-REVERSIBLE COMPRESSING OPERATION IS CARRIED OUT
TOTAL NODE NUMBER OF SHAPE DATA AFTER COMPRESSING OPERATION
NODE NUMBER p1
X-DIRECTION ABSOLUTE COORDINATE (LONGITUDE) OF NODE 1
Y-DIRECTION ABSOLUTE COORDINATE (LONGITUDE) OF NODE 1
SHAPE DATA WHICH HAS BEEN NONREVERSIBLE-COMPRESSED
⋮ ⋮
SHAPE VECTOR STREAM IDENTIFICATION NUMBER = 100
⋮ ⋮
SHAPE VECTOR STREAM IDENTIFICATION NUMBER = ZZ
⋮ ⋮

FIG. 25

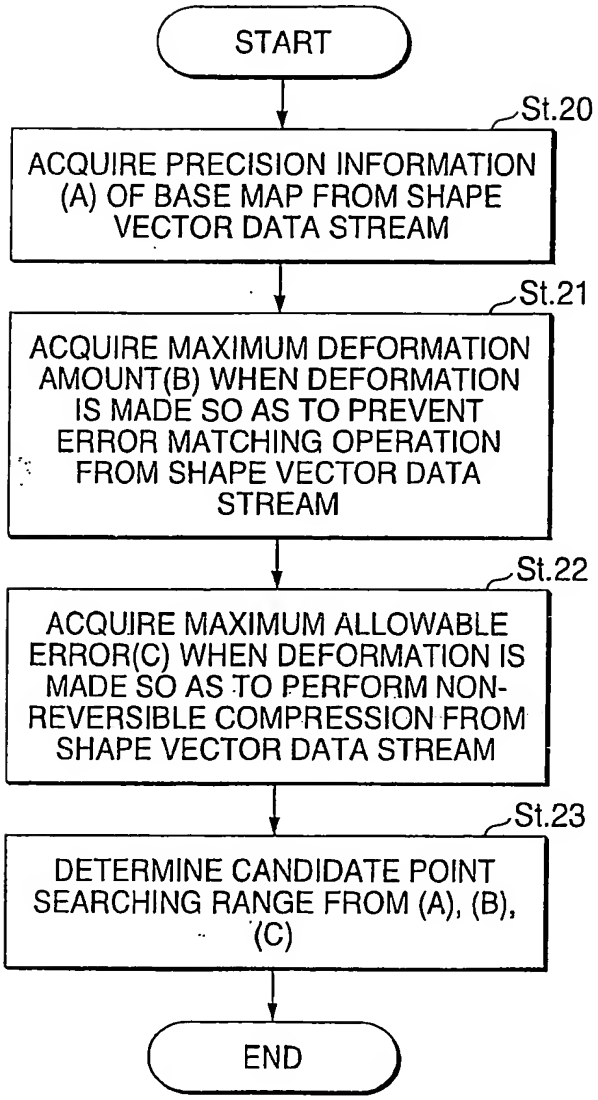

START
St.20
ACQUIRE PRECISION INFORMATION (A) OF BASE MAP FROM SHAPE VECTOR DATA STREAM
St.21
ACQUIRE MAXIMUM DEFORMATION AMOUNT(B) WHEN DEFORMATION IS MADE SO AS TO PREVENT ERROR MATCHING OPERATION FROM SHAPE VECTOR DATA STREAM
St.22
ACQUIRE MAXIMUM ALLOWABLE ERROR(C) WHEN DEFORMATION IS MADE SO AS TO PERFORM NON-REVERSIBLE COMPRESSION FROM SHAPE VECTOR DATA STREAM
St.23
DETERMINE CANDIDATE POINT SEARCHING RANGE FROM (A), (B), (C)
END

FIG. 26

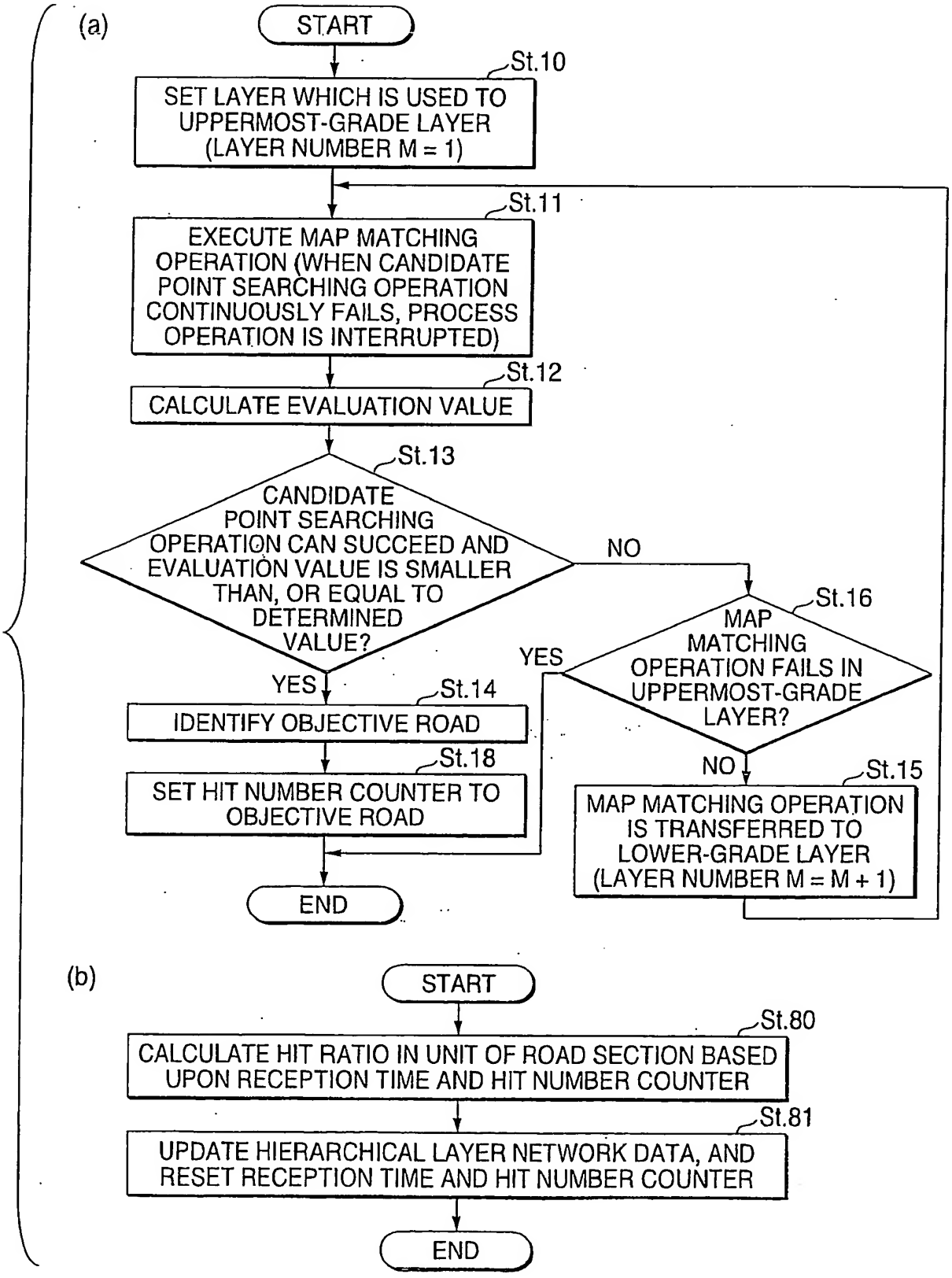

(a)
START
St.10
SET LAYER WHICH IS USED TO UPPERMOST-GRADE LAYER (LAYER NUMBER M = 1)
St.11
EXECUTE MAP MATCHING OPERATION (WHEN CANDIDATE POINT SEARCHING OPERATION CONTINUOUSLY FAILS, PROCESS OPERATION IS INTERRUPTED)
St.12
CALCULATE EVALUATION VALUE
St.13
CANDIDATE POINT SEARCHING OPERATION CAN SUCCEED AND EVALUATION VALUE IS SMALLER THAN, OR EQUAL TO DETERMINED VALUE?
NO
YES
St.16
MAP MATCHING OPERATION FAILS IN UPPERMOST-GRADE LAYER?
YES
NO
St.14
IDENTIFY OBJECTIVE ROAD
St.18
SET HIT NUMBER COUNTER TO OBJECTIVE ROAD
St.15
MAP MATCHING OPERATION IS TRANSFERRED TO LOWER-GRADE LAYER (LAYER NUMBER M = M + 1)
END
(b)
START
St.80
CALCULATE HIT RATIO IN UNIT OF ROAD SECTION BASED UPON RECEPTION TIME AND HIT NUMBER COUNTER
St.81
UPDATE HIERARCHICAL LAYER NETWORK DATA, AND RESET RECEPTION TIME AND HIT NUMBER COUNTER
END

FIG. 27

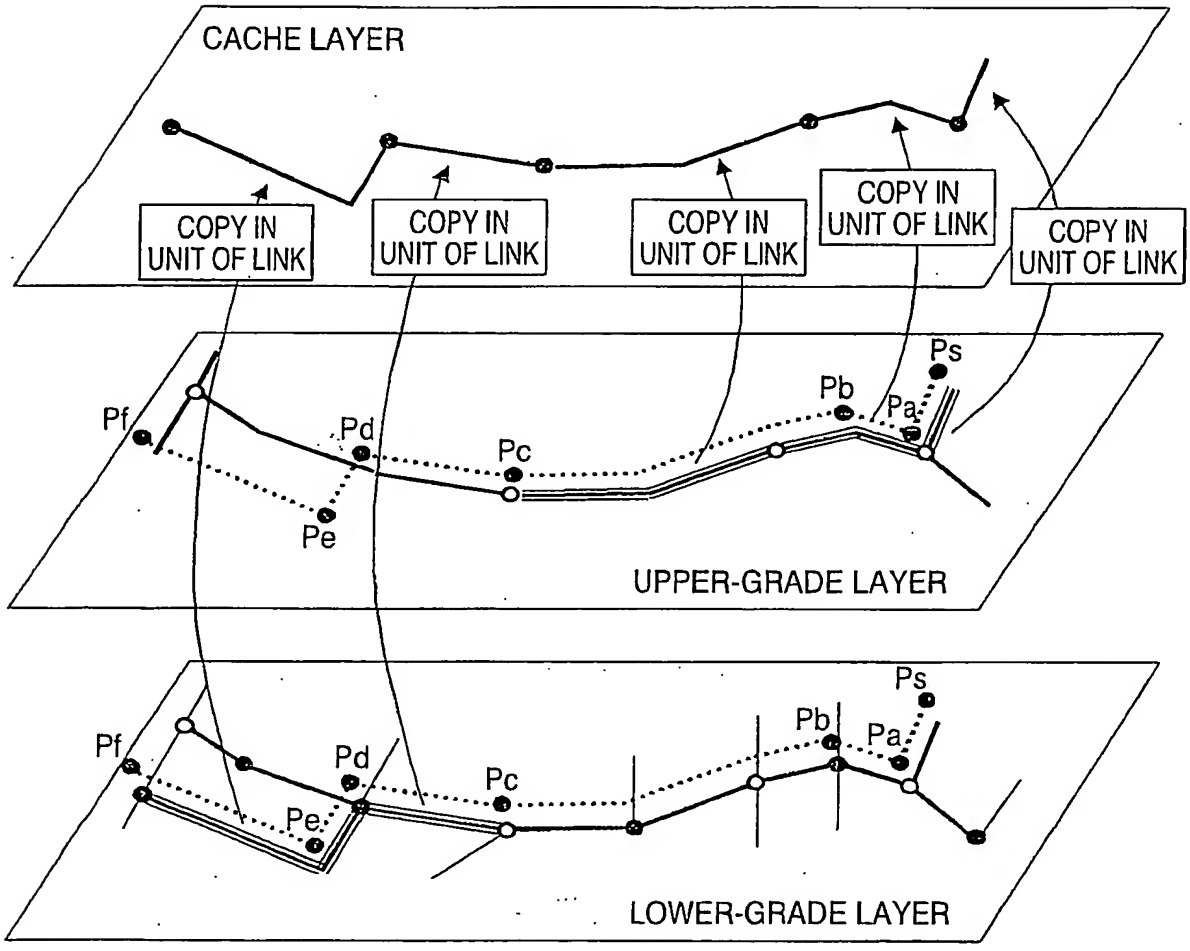

CACHE LAYER
COPY IN UNIT OF LINK
COPY IN UNIT OF LINK
COPY IN UNIT OF LINK
COPY IN UNIT OF LINK
COPY IN UNIT OF LINK
Pf
Pd
Pc
Pe
Pb
Pa
Ps
UPPER-GRADE LAYER
Pf
Pd
Pc
Pe
Pb
Pa
Ps
LOWER-GRADE LAYER
: LINK WHICH IS HIT IN RELEVANT LAYER

FIG. 28

UPPER-GRADE ROAD NETWORK DATA

(a)

HEADER INFORMATION (HIERARCHICAL LAYER NUMBER/SECTION DEFINITION ETC.)
TOTAL NODE NUMBER N1
NODE NUMBER 1
ATTRIBUTE INFORMATION OF NODE 1
LONGITUDE OF NODE 1 / LATITUDE OF NODE 1
TOTAL NUMBER OF NODES CONNECTED TO NODE 1
CONNECTION NODE NUMBER #J1 / LINK NUMBER #J1-1
⋮
CONNECTION NODE NUMBER #Jm / LINK NUMBER #J1-m
⋮ ⋮
NODE NUMBER S
NODE ATTRIBUTE INFORMATION OF NODE S
LONGITUDE OF NODE S / LATITUDE OF NODE S
TOTAL NUMBER OF NODES CONNECTED TO NODE S (=2)
CONNECTION NODE NUMBER #J1 / LINK NUMBER #SJ1
CONNECTION NODE NUMBER #J2 / LINK NUMBER #SJ2
⋮ ⋮
TOTAL LINK NUMBER L1
LINK NUMBER A
ROAD ATTRIBUTE INFORMATION OF LINK A
PARALLEL-TRAVELING RESEMBLING SHAPE ATTRIBUTE OF LINK A
TOTAL STRUCTURAL INTERPOLATION POINT NUMBER OF LINK A
LONGITUDE OF INTERPOLATION POINT A-1 / LATITUDE OF INTERPOLATION POINT A-1
⋮
LONGITUDE OF INTERPOLATION POINT A-p / LATITUDE OF INTERPOLATION POINT A-p
⋮ ⋮
LINK NUMBER SJ1
ROAD ATTRIBUTE INFORMATION OF LINK SJ1
PARALLEL-TRAVELING CONNECTING SHAPE ATTRIBUTE OF LINK SJ1
TOTAL STRUCTURAL INTERPOLATION POINT OF LINK SJ1
LONGITUDE OF INTERPOLATION POINT 1 / LATITUDE OF INTERPOLATION POINT 1
⋮
LONGITUDE OF INTERPOLATION POINT p / LATITUDE OF INTERPOLATION POINT p
⋮ ⋮

(CONT.)

(b) LOWER-GRADE ROAD NETWORK DATA

HEADER INFORMATION (HIERARCHICAL LAYER NUMBER/SECTION DEFINITION ETC.)	
TOTAL NODE NUMBER N1	
NODE NUMBER 1	
ATTRIBUTE INFORMATION OF NODE 1	
LONGITUDE OF NODE 1	LATITUDE OF NODE 1
TOTAL NUMBER OF NODES CONNECTED TO NODE 1	
CONNECTION NODE NUMBER #1	LINK NUMBER #1-1
⋮	
CONNECTION NODE NUMBER #m	LINK NUMBER #1-m
⋮ ⋮	
NODE NUMBER S	
NODE ATTRIBUTE INFORMATION OF NODE S	
LONGITUDE OF NODE S	LATITUDE OF NODE S
TOTAL NUMBER OF NODES CONNECTED TO NODE S (=3)	
CONNECTION NODE NUMBER #K1	LINK NUMBER #SK1
CONNECTION NODE NUMBER #K2	LINK NUMBER #SK2
CONNECTION NODE NUMBER #K3	LINK NUMBER #SK3
⋮ ⋮	
TOTAL LINK NUMBER L2	
LINK NUMBER B	
ROAD ATTRIBUTE INFORMATION OF LINK B	
PARALLEL-TRAVELING RESEMBLING SHAPE ATTRIBUTE OF LINK B	
TOTAL STRUCTURAL INTERPOLATION POINT NUMBER OF LINK B	
LONGITUDE OF INTERPOLATION POINT B-1	LATITUDE OF INTERPOLATION POINT B-1
⋮	
LONGITUDE OF INTERPOLATION POINT B-p	LATITUDE OF INTERPOLATION POINT B-p
⋮ ⋮	
LINK NUMBER SK2	
ROAD ATTRIBUTE INFORMATION OF LINK SK2	
PARALLEL-TRAVELING CONNECTING SHAPE ATTRIBUTE OF LINK SK2	
TOTAL STRUCTURAL INTERPOLATION POINT OF LINK SK2	
LONGITUDE OF INTERPOLATION POINT 1	LATITUDE OF INTERPOLATION POINT 1
⋮	
LONGITUDE OF INTERPOLATION POINT p'	LATITUDE OF INTERPOLATION POINT p'
⋮ ⋮	

(FIG. 28 CONTINUED)

(CONT.)

(c)

CACHE LAYER ROAD NETWORK DATA (HATCHED PORTIONS OF UPPER-GRADE/LOWER-GRADE LAYER DATA ARE COPIED, AND EVERY TIME TOTAL NUMBER OF NODES IS CALCULATED, CACHE LAYER ROAD NETWORK DATA IS PRODUCED)

HEADER INFORMATION (HIERARCHICAL LAYER NUMBER/SECTION DEFINITION ETC.)
TOTAL NODE NUMBER N (SEQUENTIALLY ADD EVERY COPY)
⋮ ⋮
NODE NUMBER S
ATTRIBUTE INFORMATION OF NODE S
LONGITUDE OF NODE S / LATITUDE OF NODE S
TOTAL NUMBER OF NODES CONNECTED TO NODE S (=2)
CONNECTION NODE NUMBER #J1 / LINK NUMBER #SJ1
CONNECTION NODE NUMBER #K2 / LINK NUMBER #SK2
⋮ ⋮
TOTAL LINK NUMBER L (SEQUENTIALLY ADD EVERY COPY)
⋮ ⋮
LINK NUMBER SJ1
ROAD ATTRIBUTE INFORMATION OF LINK SJ1
PARALLEL-TRAVELING RESEMBLING SHAPE ATTRIBUTE OF LINK SJ1
TOTAL STRUCTURAL INTERPOLATION POINT OF LINK SJ1
LONGITUDE OF INTERPOLATION POINT 1 / LATITUDE OF INTERPOLATION POINT 1
⋮
LONGITUDE OF INTERPOLATION POINT p / LATITUDE OF INTERPOLATION POINT p
⋮ ⋮
LINK NUMBER SK2
ROAD ATTRIBUTE INFORMATION OF LINK SK2
PARALLEL-TRAVELING CONNECTING SHAPE ATTRIBUTE OF LINK SK2
TOTAL STRUCTURAL INTERPOLATION POINT NUMBER OF LINK SK2
LONGITUDE OF INTERPOLATION POINT 1 / LATITUDE OF INTERPOLATION POINT 1
⋮
LONGITUDE OF INTERPOLATION POINT p' / LATITUDE OF INTERPOLATION POINT p'
⋮ ⋮

(FIG. 28(b) CONTINUED)

FIG. 29

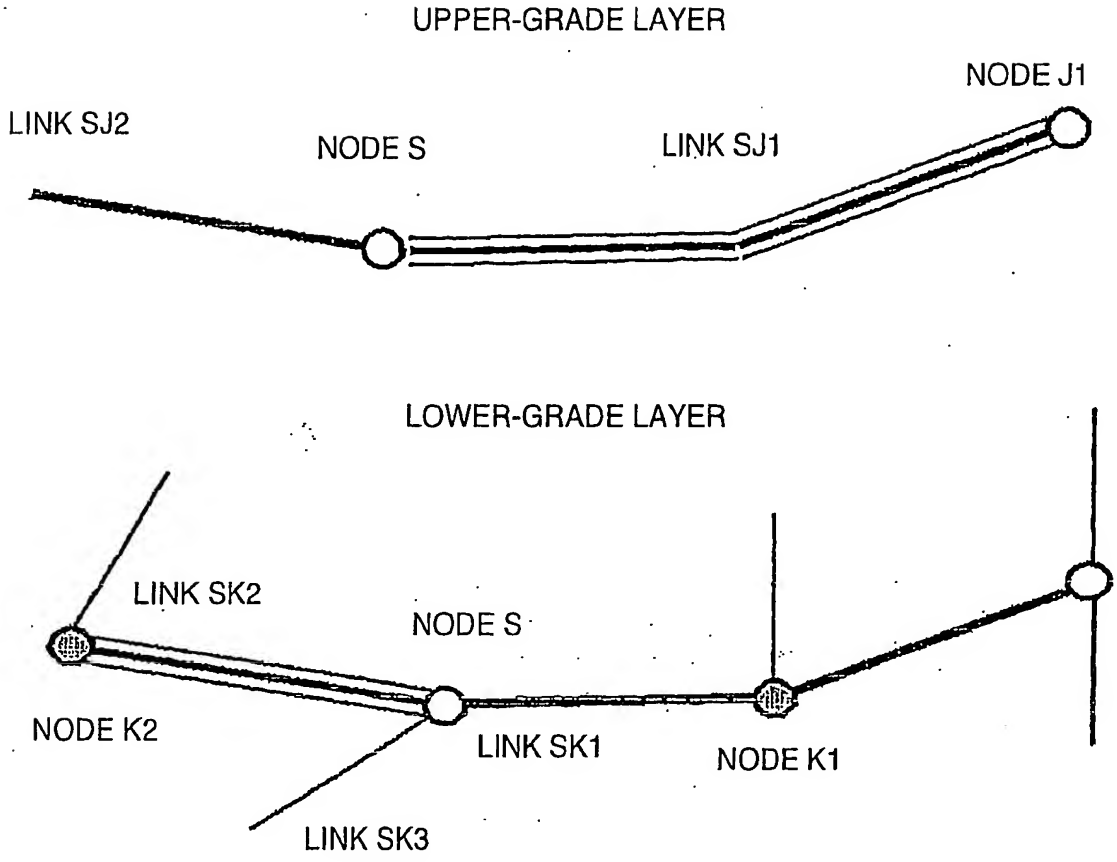

UPPER-GRADE LAYER
NODE J1
LINK SJ2
NODE S
LINK SJ1
LOWER-GRADE LAYER
LINK SK2
NODE S
NODE K2
LINK SK1
NODE K1
LINK SK3
: LINK WHICH IS HIT IN RELEVANT LAYER

FIG. 30

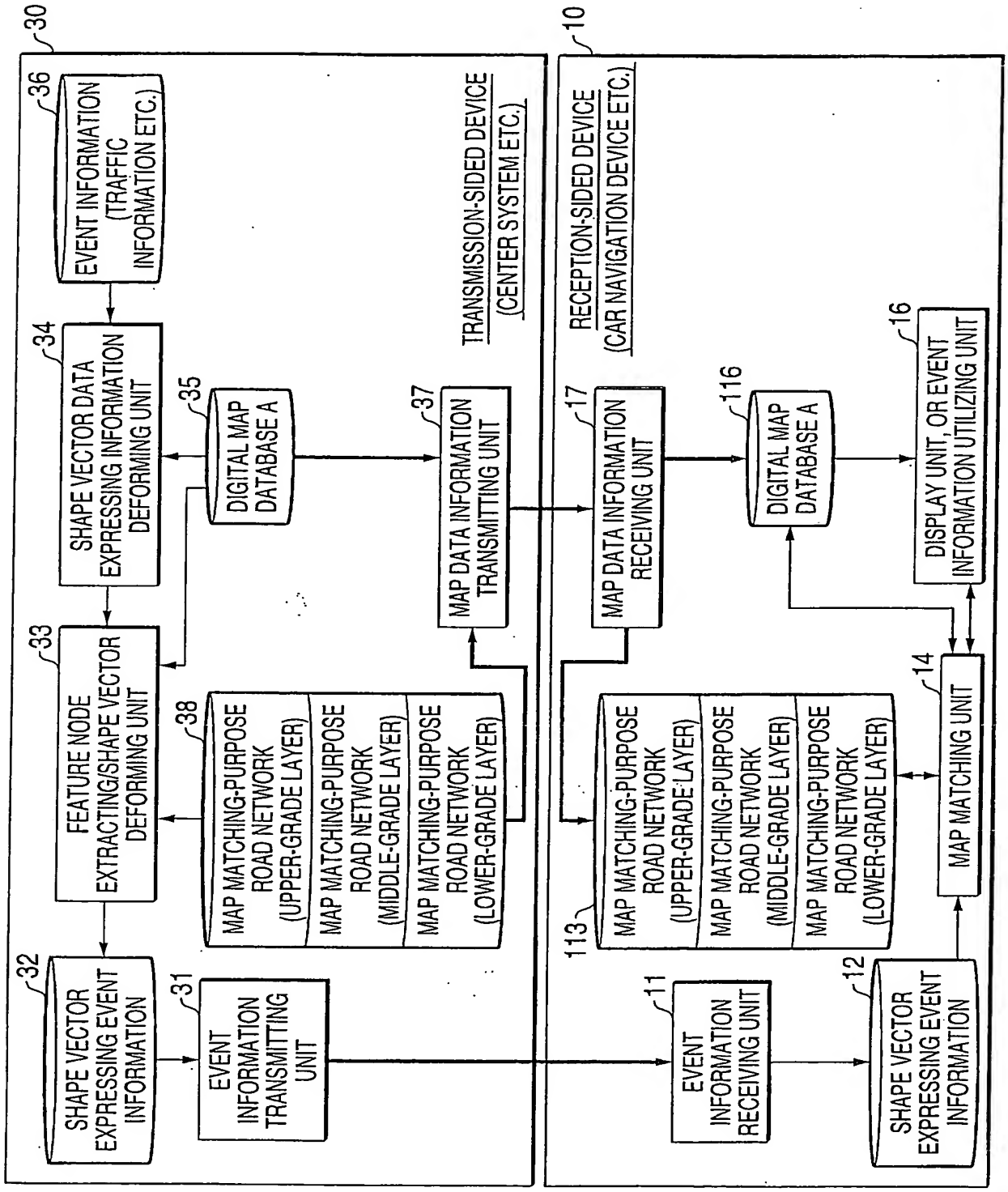

30
TRANSMISSION-SIDED DEVICE (CENTER SYSTEM ETC.)
36
EVENT INFORMATION (TRAFFIC INFORMATION ETC.)
34
SHAPE VECTOR DATA EXPRESSING INFORMATION DEFORMING UNIT
35
DIGITAL MAP DATABASE A
37
MAP DATA INFORMATION TRANSMITTING UNIT
33
FEATURE NODE EXTRACTING/SHAPE VECTOR DEFORMING UNIT
38
MAP MATCHING-PURPOSE ROAD NETWORK (UPPER-GRADE LAYER)
MAP MATCHING-PURPOSE ROAD NETWORK (MIDDLE-GRADE LAYER)
MAP MATCHING-PURPOSE ROAD NETWORK (LOWER-GRADE LAYER)
32
SHAPE VECTOR EXPRESSING EVENT INFORMATION
31
EVENT INFORMATION TRANSMITTING UNIT
10
RECEPTION-SIDED DEVICE (CAR NAVIGATION DEVICE ETC.)
17
MAP DATA INFORMATION RECEIVING UNIT
116
DIGITAL MAP DATABASE A
16
DISPLAY UNIT, OR EVENT INFORMATION UTILIZING UNIT
113
MAP MATCHING-PURPOSE ROAD NETWORK (UPPER-GRADE LAYER)
MAP MATCHING-PURPOSE ROAD NETWORK (MIDDLE-GRADE LAYER)
MAP MATCHING-PURPOSE ROAD NETWORK (LOWER-GRADE LAYER)
14
MAP MATCHING UNIT
11
EVENT INFORMATION RECEIVING UNIT
12
SHAPE VECTOR EXPRESSING EVENT INFORMATION

FIG. 31

EXAMPLE 1, SHAPE VECTOR DATA STREAM (HIERARCHICAL LAYER JUDGING INFORMATION IS ADDED IN UNIT OF SHAPE VECTOR)

(a)

SHAPE VECTOR STREAM IDENTIFICATION NUMBER = 1
HIERARCHICAL LAYER NUMBER
ROAD ATTRIBUTE (ROAD SORT ETC.)
TOTAL NODE NUMBER
NODE NUMBER p1
X DIRECTION ABSOLUTE COORDINATE (LONGITUDE) OF NODE 1
Y DIRECTION ABSOLUTE COORDINATE (LONGITUDE) OF NODE 1
ABSOLUTE AZIMUTH OF NODE 1
⋮
NODE NUMBER pN
RELATIVE COORDINATE (xn) OF NODE N
RELATIVE COORDINATE (yn) OF NODE N
RELATIVE AZIMUTH OF NODE N
⋮ ⋮
SHAPE VECTOR STREAM IDENTIFICATION NUMBER = 100
⋮ ⋮
SHAPE VECTOR STREAM IDENTIFICATION NUMBER = ZZ
⋮ ⋮

(CONT.)

(FIG. 31 CONTINUED)

(b) EXAMPLE 2, SHAPE VECTOR DATA STREAM (HIERARCHICAL LAYER JUDGING INFORMATION IS ADDED IN UNIT OF NODE)

SHAPE VECTOR STREAM IDENTIFICATION NUMBER = 1
TOTAL NODE NUMBER
NODE NUMBER p1
HIERARCHICAL LAYER NUMBER OF NODE 1 / ROAD ATTRIBUTE OF NODE 1
X DIRECTION ABSOLUTE COORDINATE (LONGITUDE) OF NODE 1
Y DIRECTION ABSOLUTE COORDINATE (LONGITUDE) OF NODE 1
ABSOLUTE AZIMUTH OF NODE 1
⋮
NODE NUMBER pN
HIERARCHICAL LAYER NUMBER OF NODE N / ROAD ATTRIBUTE OF NODE N
RELATIVE COORDINATE (xn) OF NODE N
RELATIVE COORDINATE (yn) OF NODE N
RELATIVE AZIMUTH OF NODE N
⋮ ⋮
SHAPE VECTOR STREAM IDENTIFICATION NUMBER = 100
⋮ ⋮
SHAPE VECTOR STREAM IDENTIFICATION NUMBER = ZZ
⋮ ⋮

FIG. 32

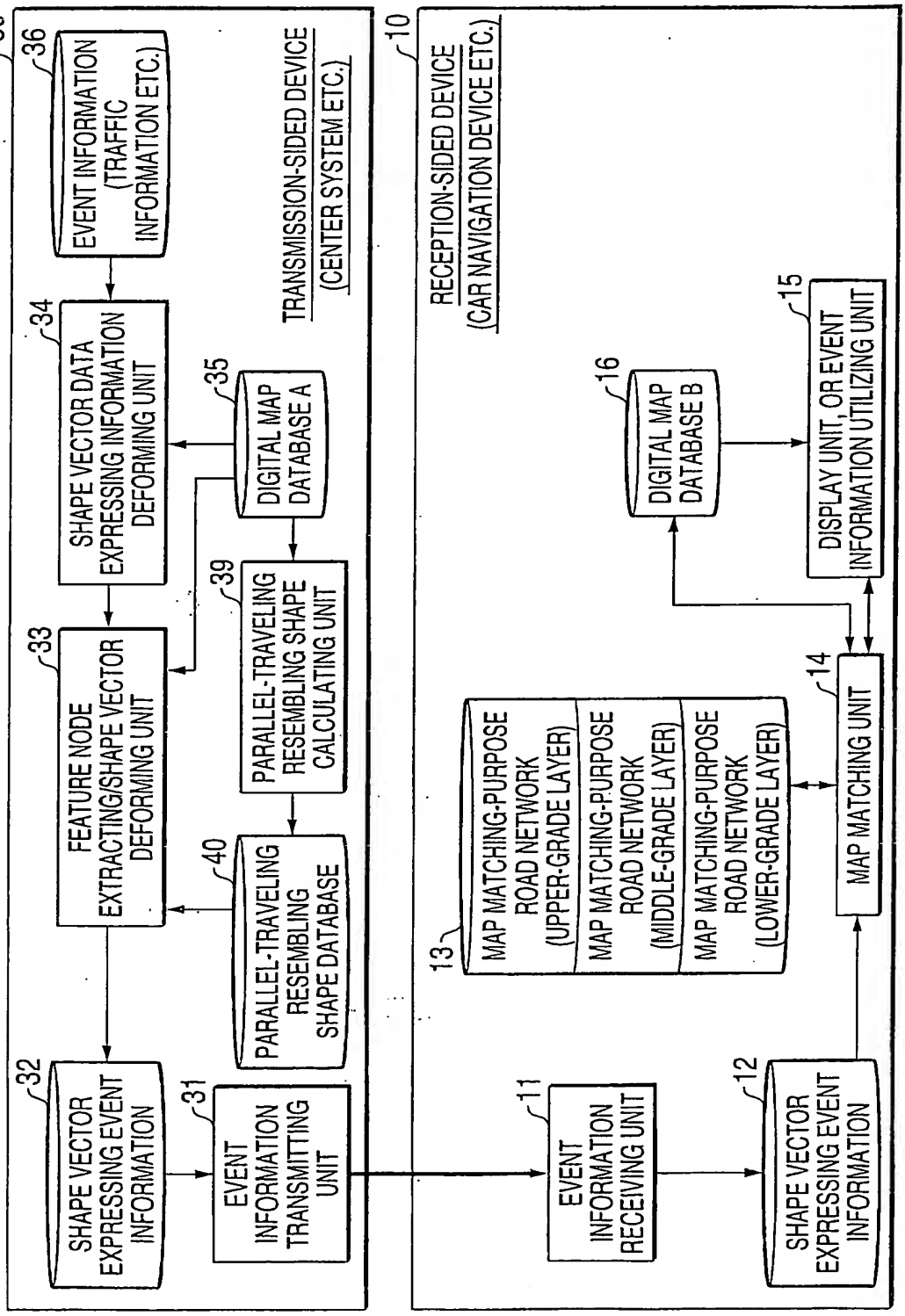

30
TRANSMISSION-SIDED DEVICE (CENTER SYSTEM ETC.)
36
EVENT INFORMATION (TRAFFIC INFORMATION ETC.)
34
SHAPE VECTOR DATA EXPRESSING INFORMATION DEFORMING UNIT
35
DIGITAL MAP DATABASE A
33
FEATURE NODE EXTRACTING/SHAPE VECTOR DEFORMING UNIT
39
PARALLEL-TRAVELING RESEMBLING SHAPE CALCULATING UNIT
40
PARALLEL-TRAVELING RESEMBLING SHAPE DATABASE
32
SHAPE VECTOR EXPRESSING EVENT INFORMATION
31
EVENT INFORMATION TRANSMITTING UNIT
10
RECEPTION-SIDED DEVICE (CAR NAVIGATION DEVICE ETC.)
13
MAP MATCHING-PURPOSE ROAD NETWORK (UPPER-GRADE LAYER)
MAP MATCHING-PURPOSE ROAD NETWORK (MIDDLE-GRADE LAYER)
MAP MATCHING-PURPOSE ROAD NETWORK (LOWER-GRADE LAYER)
16
DIGITAL MAP DATABASE B
15
DISPLAY UNIT, OR EVENT INFORMATION UTILIZING UNIT
14
MAP MATCHING UNIT
11
EVENT INFORMATION RECEIVING UNIT
12
SHAPE VECTOR EXPRESSING EVENT INFORMATION

FIG. 33

< PARALLEL-TRAVELING RESEMBLING SHAPE EXTRACTING PROCESS OPERATION >

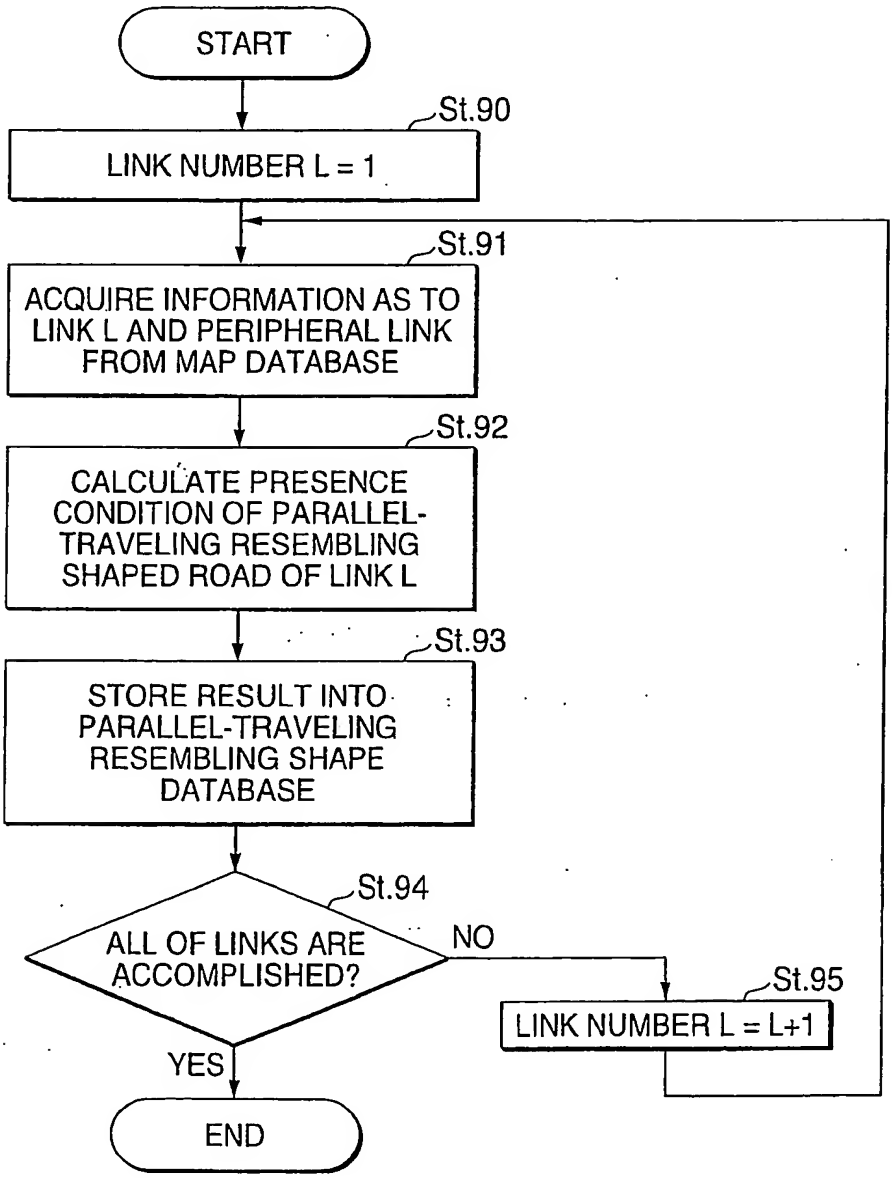


FIG. 34

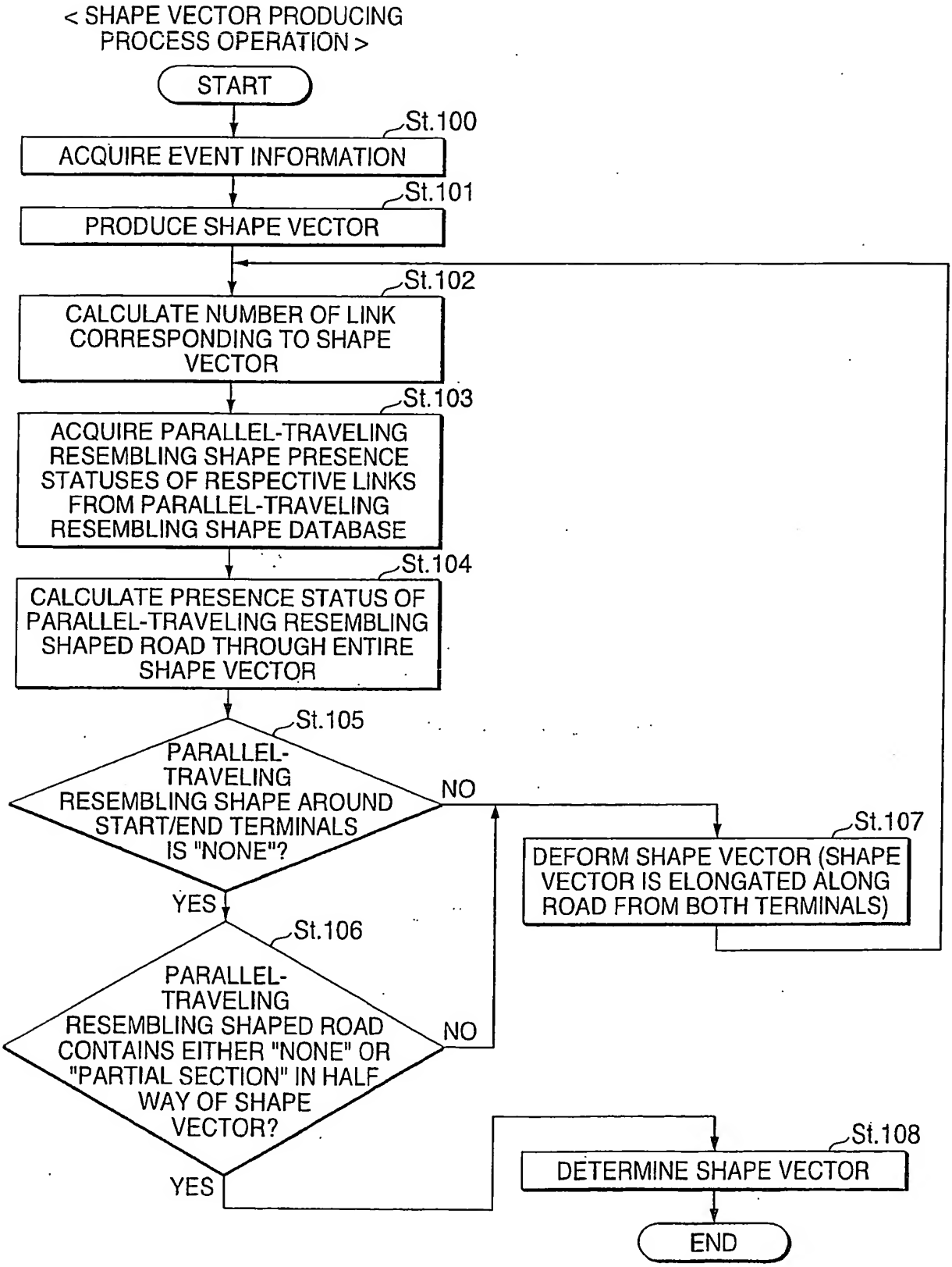

< SHAPE VECTOR PRODUCING PROCESS OPERATION >
START
St.100
ACQUIRE EVENT INFORMATION
St.101
PRODUCE SHAPE VECTOR
St.102
CALCULATE NUMBER OF LINK CORRESPONDING TO SHAPE VECTOR
St.103
ACQUIRE PARALLEL-TRAVELING RESEMBLING SHAPE PRESENCE STATUSES OF RESPECTIVE LINKS FROM PARALLEL-TRAVELING RESEMBLING SHAPE DATABASE
St.104
CALCULATE PRESENCE STATUS OF PARALLEL-TRAVELING RESEMBLING SHAPED ROAD THROUGH ENTIRE SHAPE VECTOR
St.105
PARALLEL-TRAVELING RESEMBLING SHAPE AROUND START/END TERMINALS IS "NONE"?
NO
YES
St.107
DEFORM SHAPE VECTOR (SHAPE VECTOR IS ELONGATED ALONG ROAD FROM BOTH TERMINALS)
St.106
PARALLEL-TRAVELING RESEMBLING SHAPED ROAD CONTAINS EITHER "NONE" OR "PARTIAL SECTION" IN HALF WAY OF SHAPE VECTOR?
NO
YES
St.108
DETERMINE SHAPE VECTOR
END

FIG. 35

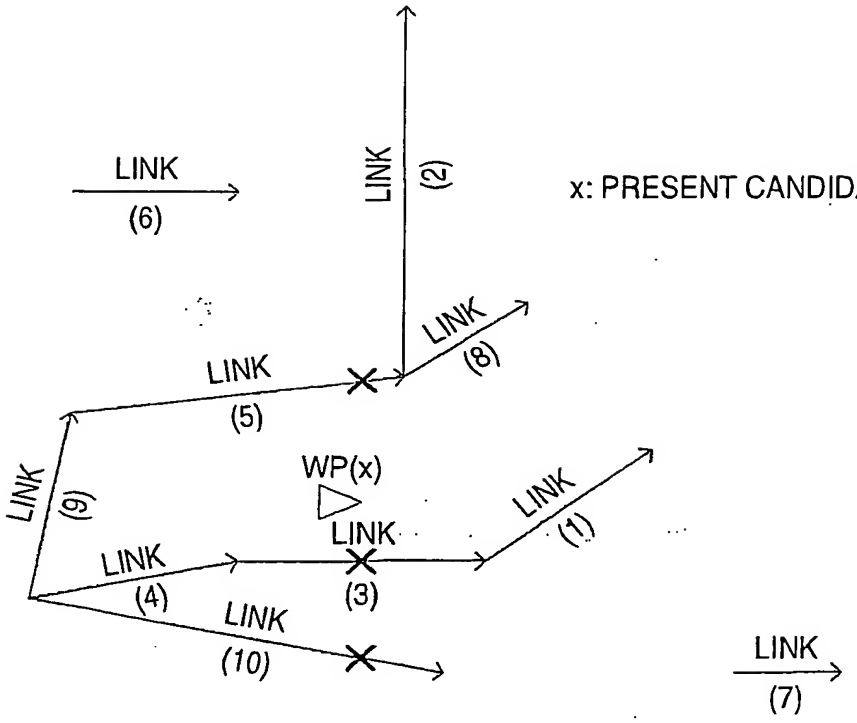

LINK
(6)
LINK
(2)
x: PRESENT CANDIDATE OF WP(x)
LINK
(8)
LINK
(5)
LINK
(9)
WP(x)
LINK
(1)
LINK
(4)
LINK
(3)
LINK
(10)
LINK
(7)

FIG. 36

(a) SHAPE VECTOR DATA STREAM

SHAPE VECTOR STREAM IDENTIFICATION NUMBER = 1
SORT OF VECTOR DATA (= ROAD)
TOTAL NODE NUMBER
NODE NUMBER p1
X DIRECTION ABSOLUTE COORDINATE (LONGITUDE) OF NODE 1
Y DIRECTION ABSOLUTE COORDINATE (LONGITUDE) OF NODE 1
ABSOLUTE AZIMUTH OF NODE 1
⋮
NODE NUMBER pN
RELATIVE COORDINATE (xn) OF NODE N
RELATIVE COORDINATE (yn) OF NODE N
RELATIVE AZIMUTH OF NODE N
⋮ ⋮
SHAPE VECTOR STREAM IDENTIFICATION NUMBER = 100
⋮ ⋮
SHAPE VECTOR STREAM IDENTIFICATION NUMBER = ZZ
⋮ ⋮

(CONT.)

(FIG. 36 CONTINUED)

(b) TRAVEL TIME INFORMATION

TOTAL NUMBER V OF TRAVEL TIME PROVIDING SECTIONS	
PROVIDED TRAVEL TIME SERIAL NUMBER = 1	
REFERENCE SHAPE VECTOR STREAM NUMBER = 8	
DIRECTION IDENTIFICATION FLAG (FORWARD DIRECTION/REVERSE DIRECTION)	
REFERENCE NODE Pa OF STARTING TERMINAL SIDE	RELATIVE DISTANCE La OF STRATTON TERMINAL SIDE
REFERENCE NODE Pb OF END TERMINAL SIDE	RELATIVE DISTANCE Lb OF STRATTON TERMINAL SIDE
TRAVEL TIME T1 BETWEEN STARTING TERMINAL AND END TERMINAL	
⋮ ⋮	
PROVIDED TRAVEL TIME SERIAL NUMBER V	
REFERENCE SHAPE VECTOR STREAM NUMBER = 124	
DIRECTION IDENTIFICATION FLAG (FORWARD DIRECTION/REVERSE DIRECTION)	
REFERENCE NODE Pc OF STARTING TERMINAL SIDE	RELATIVE DISTANCE Lc OF STRATTON TERMINAL SIDE
REFERENCE NODE Pd OF END TERMINAL SIDE	RELATIVE DISTANCE Ld OF STRATTON END SIDE
TRAVEL TIME Tv BETWEEN STARTING TERMINAL AND END TERMINAL = Tv	

FIG. 37

(a)

SHAPE VECTOR DATA STREAM INFORMATION (CODED/COMPRESSED DATA)

HEADER INFORMATION	
TOTAL SHAPE VECTOR NUMBER N	
SHAPE VECTOR DATA IDENTIFICATION NUMBER =1	
CODE TABLE IDENTIFICATION CODE	
PRECISION INFORMATION OF SHAPE ACQUISITION SOURCE MAP DATA	
ONE-DIRECTION TRAVEL DIRECTION (FORWARD/REVERSE/NON-DIRECTION)	
STARTING TERMINAL NODE NUMBER ps	
X DIRECTION ABSOLUTE COORDINATE (LONGITUDE) OF NODE ps	
Y DIRECTION ABSOLUTE COORDINATE (LONGITUDE) OF NODE ps	
ABSOLUTE AZIMUTH OF NODE ps	
ps POSITION ERROR(m)	ps AZIMUTH ERROR (DEGREE)
MAXIMUM POSITIONAL ERROR(m) OF CODED SHAPE DATA	MAXIMUM AZIMUTH ERROR (DEGREE) OF CODED SHAPE DATA
CODED SHAPE DATA, IT SHOULD BE NOTED THAT CODED SHAPE DATA ALSO CONTAINS FOLLOWING INFORMATION: REFERENCE CODE SETTING CODE, SECTION LENGTH CHANGING CODE, EOD CODE	
END TERMINAL NODE NUMBER pe	
X DIRECTION ABSOLUTE COORDINATE (LONGITUDE) OF NODE pe	
Y DIRECTION ABSOLUTE COORDINATE (LONGITUDE) OF NODE pe	
ABSOLUTE AZIMUTH OF NODE pe	
pe POSITION ERROR (m)	pe AZIMUTH ERROR (DEGREE)
⋮	
SHAPE VECTOR DATA IDENTIFICATION NUMBER = M	
⋮	

(CONT.)

(FIG. 37 CONTINUED)

(b) TRAFFIC INFORMATION

HEADER INFORMATION	
TOTAL NUMBER V OF TRAFFIC INFORMATION PROVIDING SECTIONS	
SERIAL NUMBER 1 OF TRAFFIC INFORMATION PROVIDING SECTION	
REFERENCE SHAPE VECTOR STREAM NUMBER = N	
DIRECTION IDENTIFICATION FLAG (FORWARD DIRECTION/REVERE DIRECTION)	
START TERMINAL-SIDED REFERENCE NODE pa	END TERMINAL-SIDED REFERENCE NODE pb
QUANTIZING SECTION LENGTH IDENTIFICATION CODE OF DISTANCE DIRECTION	
TRAFFIC INFORMATION QUANTIZING TABLE IDENTIFICATION CODE	
CODED TABLE IDENTIFICATION CODE	
TOTAL NUMBER OF QUANTIZED UNIT SECTIONS *2	
TRAFFIC INFORMATION (INITIAL VALUE) OF START TERMINAL	
TRAFFIC INFORMATION CODED BY DIFFERENCE VALUE WITH RESPECT TO PREDICTED STATISTICAL VALUE, IT SHOULD BE NOTED THAT TRAFFIC INFORMATION CONTAINS ALSO FOLLOWING INFORMATION: SECTION LENGTH CHANGING CODE AND CHANGED SECTION LENGTH, TRAFFIC INFORMATION QUANTIZED TABLE CHANGING CODE AND CHANGED TABLE NUMBER, REFERENCE NODE CORRESPONDING POINT IDENTIFICATION CODE AND CORRESPONDING REFERENCE NODE NUMBER + OFFSET DISTANCE	
⋮	
TRAFFIC INFORMATION PROVIDING SECTION SERIAL NUMBER = W	
⋮	

FIG. 38

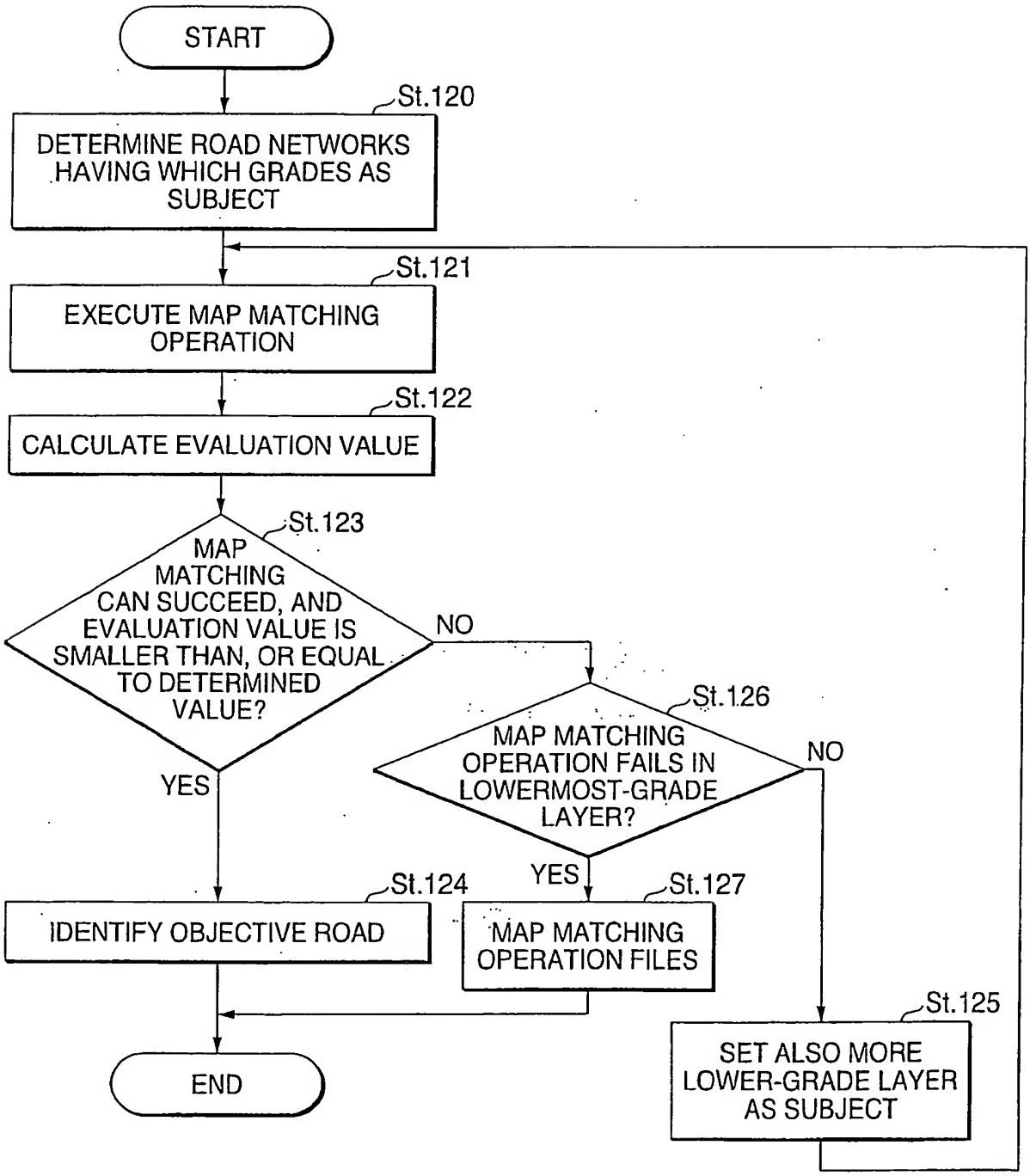

START
St.120
DETERMINE ROAD NETWORKS HAVING WHICH GRADES AS SUBJECT
St.121
EXECUTE MAP MATCHING OPERATION
St.122
CALCULATE EVALUATION VALUE
St.123
MAP MATCHING CAN SUCCEED, AND EVALUATION VALUE IS SMALLER THAN, OR EQUAL TO DETERMINED VALUE?
NO
YES
St.126
MAP MATCHING OPERATION FAILS IN LOWERMOST-GRADE LAYER?
NO
YES
St.124
IDENTIFY OBJECTIVE ROAD
St.127
MAP MATCHING OPERATION FILES
St.125
SET ALSO MORE LOWER-GRADE LAYER AS SUBJECT
END

FIG. 39

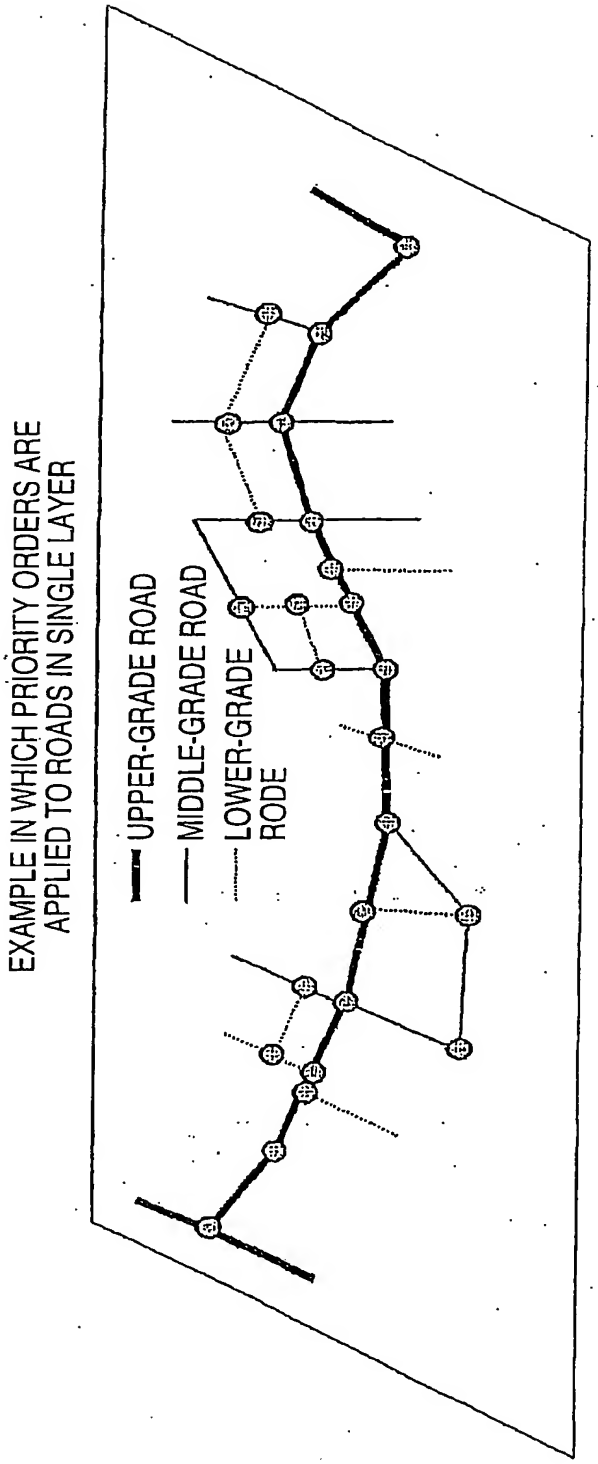

EXAMPLE IN WHICH PRIORITY ORDERS ARE APPLIED TO ROADS IN SINGLE LAYER
UPPER-GRADE ROAD
MIDDLE-GRADE ROAD
LOWER-GRADE RODE

FIG. 40

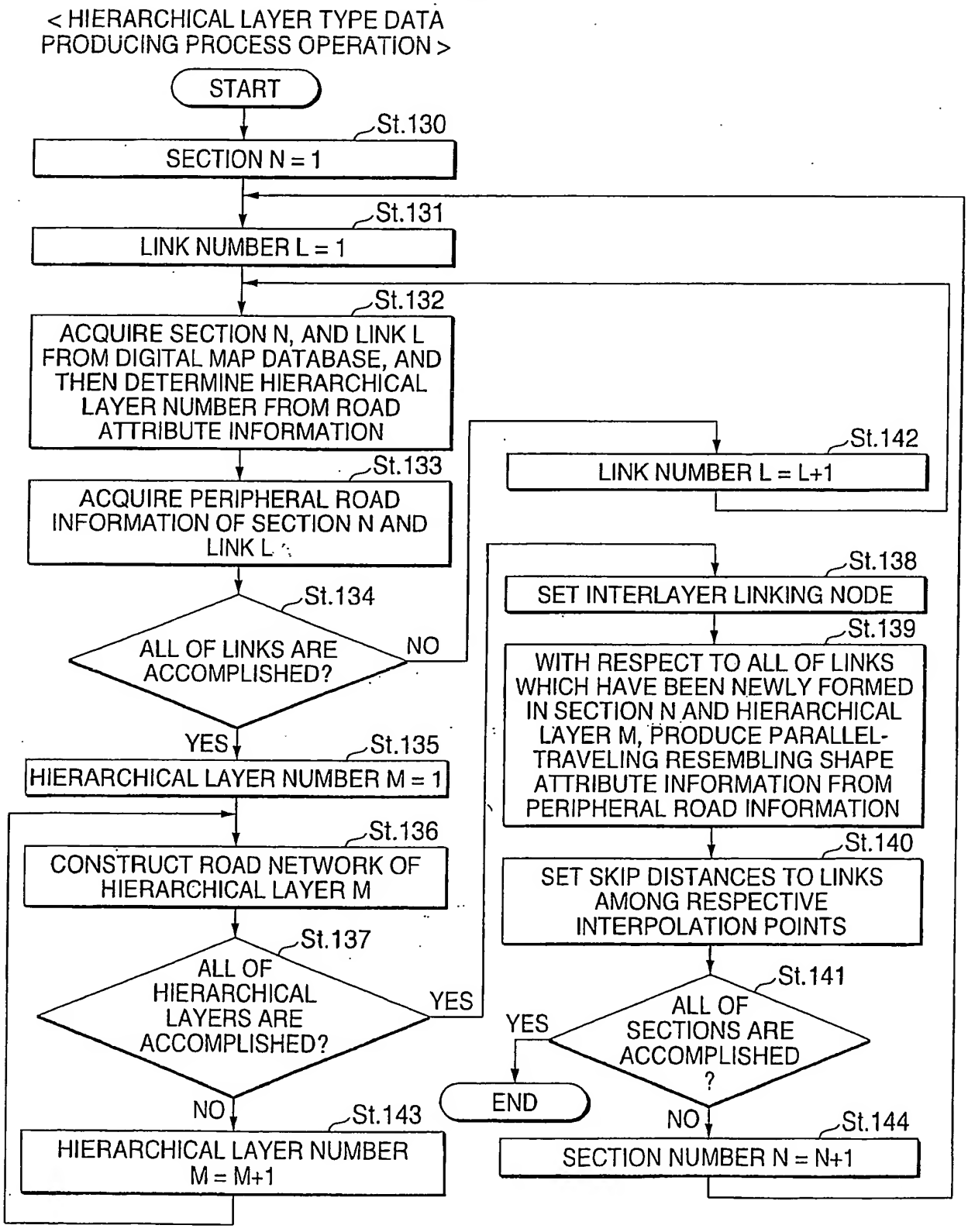
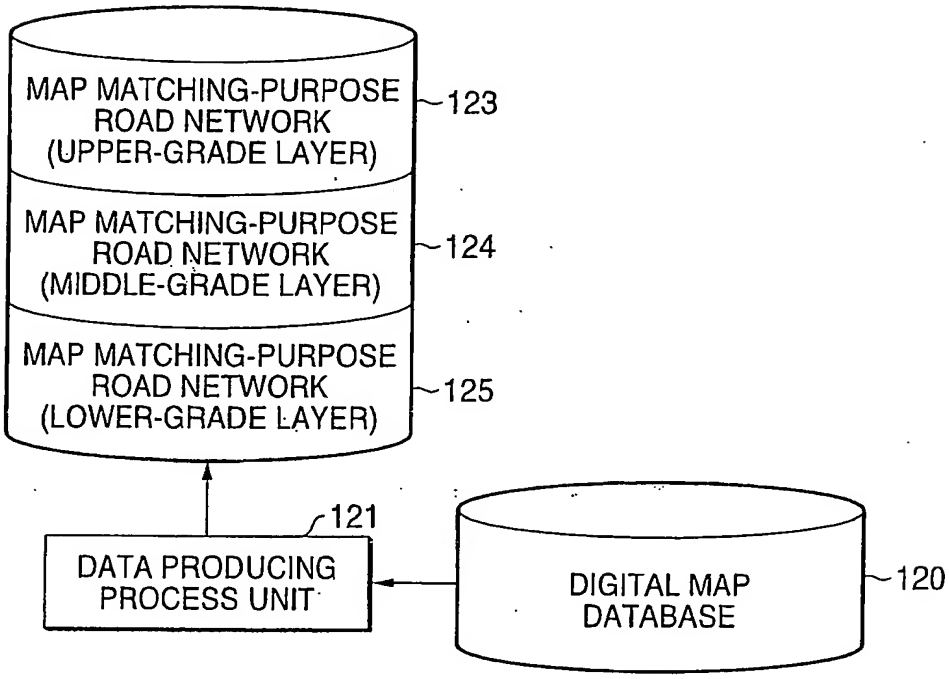

< HIERARCHICAL LAYER TYPE DATA PRODUCING PROCESS OPERATION >
START
St.130
SECTION N = 1
St.131
LINK NUMBER L = 1
St.132
ACQUIRE SECTION N, AND LINK L FROM DIGITAL MAP DATABASE, AND THEN DETERMINE HIERARCHICAL LAYER NUMBER FROM ROAD ATTRIBUTE INFORMATION
St.133
ACQUIRE PERIPHERAL ROAD INFORMATION OF SECTION N AND LINK L
St.134
ALL OF LINKS ARE ACCOMPLISHED?
NO
YES
St.135
HIERARCHICAL LAYER NUMBER M = 1
St.136
CONSTRUCT ROAD NETWORK OF HIERARCHICAL LAYER M
St.137
ALL OF HIERARCHICAL LAYERS ARE ACCOMPLISHED?
YES
NO
St.143
HIERARCHICAL LAYER NUMBER M = M+1
St.142
LINK NUMBER L = L+1
St.138
SET INTERLAYER LINKING NODE
St.139
WITH RESPECT TO ALL OF LINKS WHICH HAVE BEEN NEWLY FORMED IN SECTION N AND HIERARCHICAL LAYER M, PRODUCE PARALLEL-TRAVELING RESEMBLING SHAPE ATTRIBUTE INFORMATION FROM PERIPHERAL ROAD INFORMATION
St.140
SET SKIP DISTANCES TO LINKS AMONG RESPECTIVE INTERPOLATION POINTS
St.141
ALL OF SECTIONS ARE ACCOMPLISHED ?
YES
END
NO
St.144
SECTION NUMBER N = N+1

FIG. 41

HIERARCHICAL LAYER TYPE DATA PRODUCING DEVICE



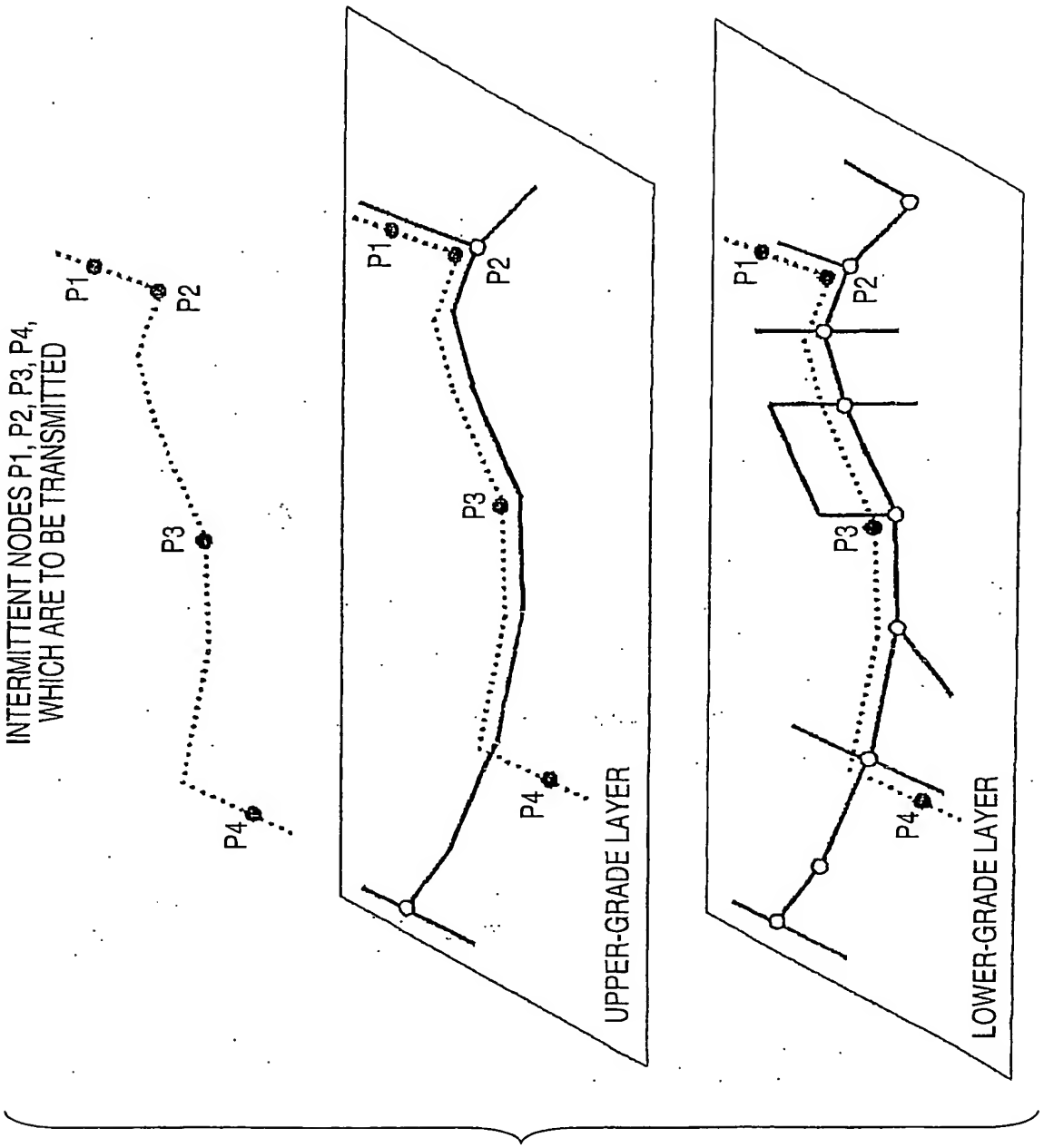

INTERMITTENT NODES P1, P2, P3, P4,
WHICH ARE TO BE TRANSMITTED
P1
P2
P3
P4
P1
P2
P3
P4
UPPER-GRADE LAYER
P1
P2
P3
P4
LOWER-GRADE LAYER

FIG. 42

FIG. 43

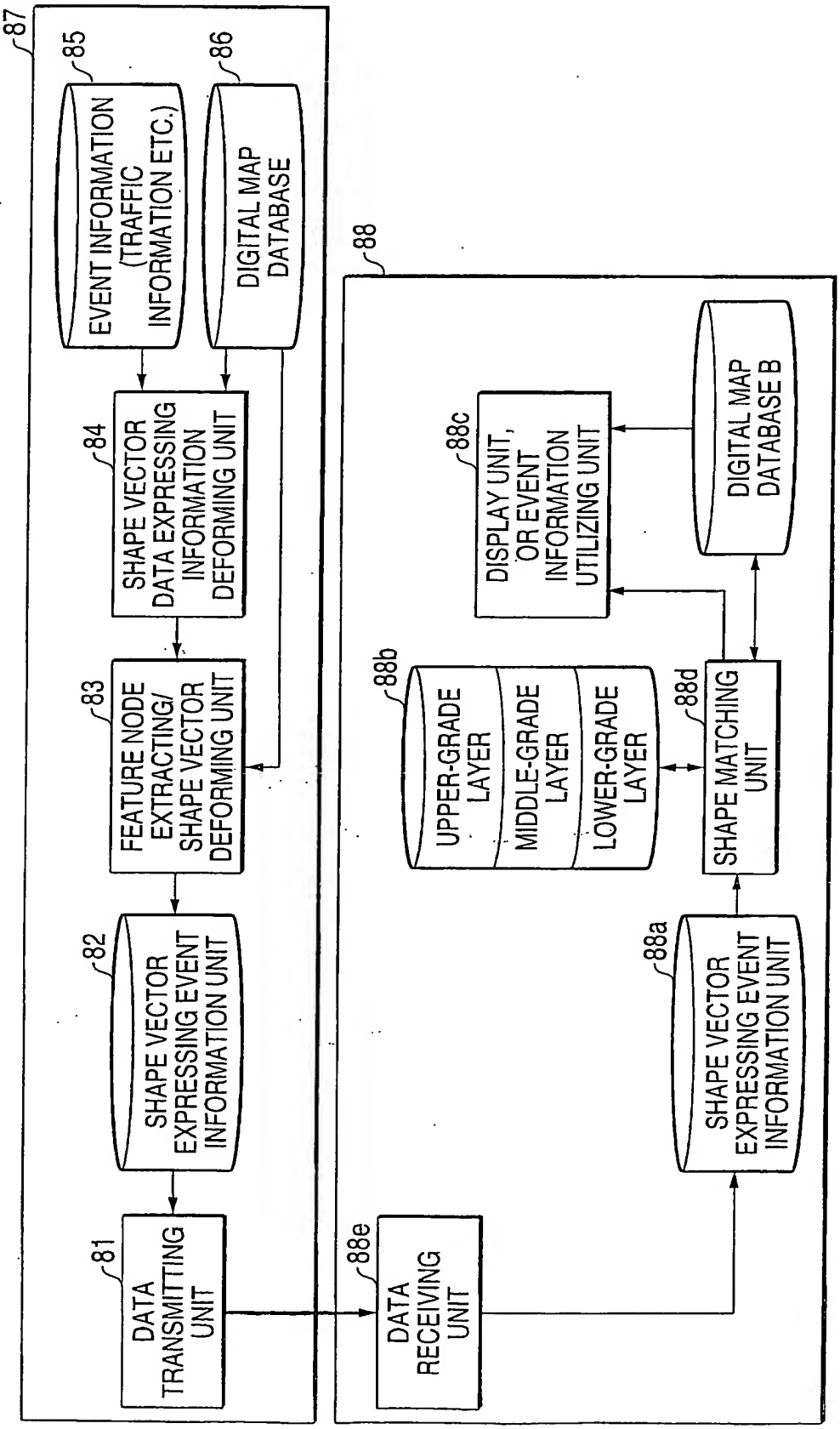

87
85
EVENT INFORMATION (TRAFFIC INFORMATION ETC.)
86
DIGITAL MAP DATABASE
84
SHAPE VECTOR DATA EXPRESSING INFORMATION DEFORMING UNIT
83
FEATURE NODE EXTRACTING/ SHAPE VECTOR DEFORMING UNIT
82
SHAPE VECTOR EXPRESSING EVENT INFORMATION UNIT
81
DATA TRANSMITTING UNIT
88
88c
DISPLAY UNIT, OR EVENT INFORMATION UTILIZING UNIT
DIGITAL MAP DATABASE B
88b
UPPER-GRADE LAYER
MIDDLE-GRADE LAYER
LOWER-GRADE LAYER
88d
SHAPE MATCHING UNIT
88a
SHAPE VECTOR EXPRESSING EVENT INFORMATION UNIT
88e
DATA RECEIVING UNIT

FIG. 44

EVENT INFORMATION

REFERENCE SHAPE VECTOR STREAM NUMBER (= 56)	
EVENT 1 (= CLOSED-TO-ALL-VEHICLES EVENT)	
DETAILED EVENT INFORMATION (CLOSED-TO-ALL-VEHICLES ETC.)	
NODE NUMBER 1 (Pm')	NODE NUMBER 2 (Pn')
RELATIVE POSITION OF EVENT FROM Pm'	
DIRECTION IDENTIFICATION FLAG (= 1)	
⋮	
EVENT "n" (TRAFFIC JAM)	
TRAFFIC JAM DEGREE RANK	
NODE NUMBER 1 (Pm')	NODE NUMBER 2 (Pn')
EVENT RELATIVE POSITION 1 FROM Pm' (START TERMINAL SIDE OF TRAFFIC JAM)	
EVENT RELATIVE POSITION 1 FROM Pm' (END TERMINAL SIDE OF TRAFFIC JAM)	

SELECT NODES TO BE FEATURED NODES, AND SET SELECTED NODES TO NODE NUMBERS Pm, Pn, ETC.

FIG. 45

LINK INFORMATION

ROAD SORT CODE
ROAD NUMBER
TOLL ROAD CODE
START NODE NUMBER p4, AND END NODE NUMBER e4
BELONGING HIERARCHICAL LAYER: UPPER, MIDDLE, LOWER
TOTAL CONNECTION LINK NUMBER I4 OF p4
CONNECTION LINK ANGLE 1 OF p4
⋮
CONNECTION LINK ANGLE I4 OF P4
⋮
TOTAL CONNECTION LINK NUMBER In OF Pm
CONNECTION LINK ANGLE 1 OF Pm
...
CONNECTION LINK ANGLE In OF Pm

FIG. 46

NODE INFORMATION

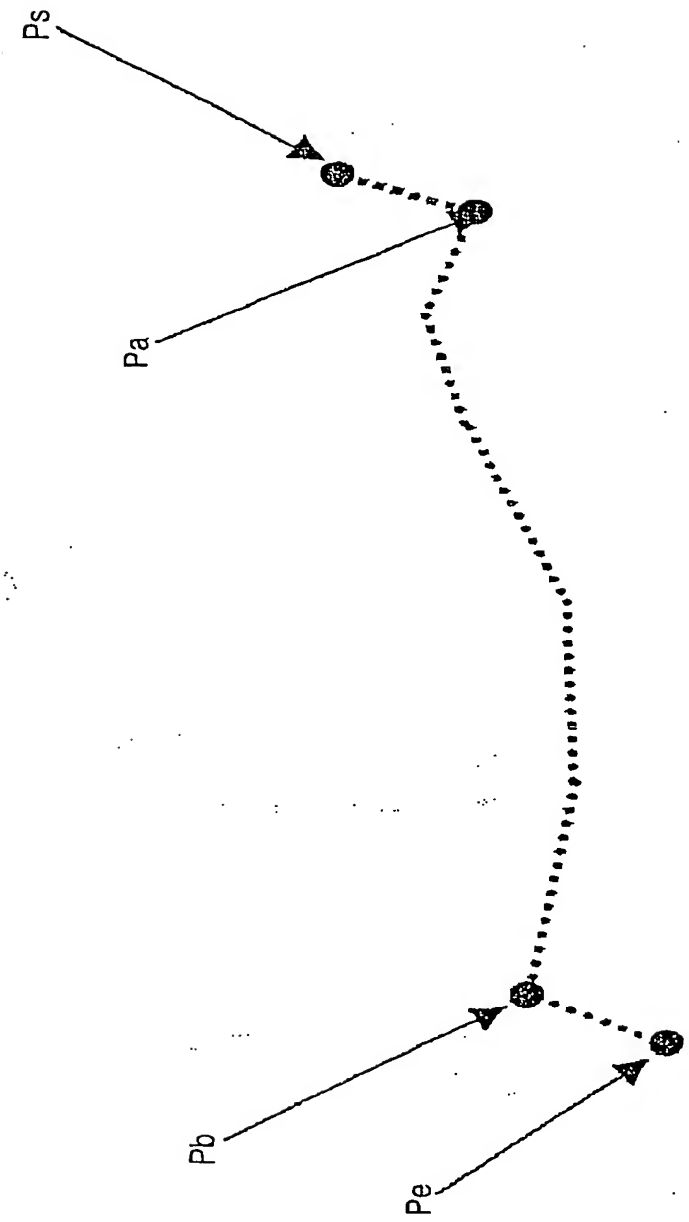
VECTOR DATA SORT (= ROAD)	
TOTAL NODE NUMBER	
BELONGING HIERARCHICAL LAYER INFORMATION	
DEFINITION ALONG FORWARD DIRECTION (= 2)	DEFINITION ALONG REVERES DIRECTION (= 1)
NODE NUMBER p1	
X DIRECTION ABSOLUTE COORDINATE (LONGITUDE) OF NODE 1	
Y DIRECTION ABSOLUTE COORDINATE (LONGITUDE) OF NODE 1	
NODE NUMBER p2	
RELATIVE COORDINATE (x2) OF NODE 2	
RELATIVE COORDINATE (y2) OF NODE 2	
⋮	
NODE NUMBER pn	
RELATIVE COORDINATE (xn) OF NODE n	
RELATIVE COORDINATE (yn) OF NODE n	

FIG. 47

SHAPE VECTOR

SHAPE VECTOR STREAM IDENTIFICATION NUMBER = 1
VECTOR DATA SORT (= ROAD)
BELONGING HIERARCHICAL LAYER (UPPER, MIDDLE, LOWER)
TOTAL NODE NUMBER
NODE NUMBER p1
X DIRECTION ABSOLUTE COORDINATE (LONGITUDE) OF NODE 1
Y DIRECTION ABSOLUTE COORDINATE (LONGITUDE) OF NODE 1
ABSOLUTE AZIMUTH OF NODE 1
⋮
NODE NUMBER pN
RELATIVE COORDINATE (xn) OF NODE N
RELATIVE COORDINATE (yn) OF NODE N
RELATIVE AZIMUTH OF NODE N
⋮ ⋮
SHAPE VECTOR STREAM IDENTIFICATION NUMBER = 56
⋮ ⋮
SHAPE VECTOR STREAM IDENTIFICATION NUMBER = 100
⋮

FIG. 48



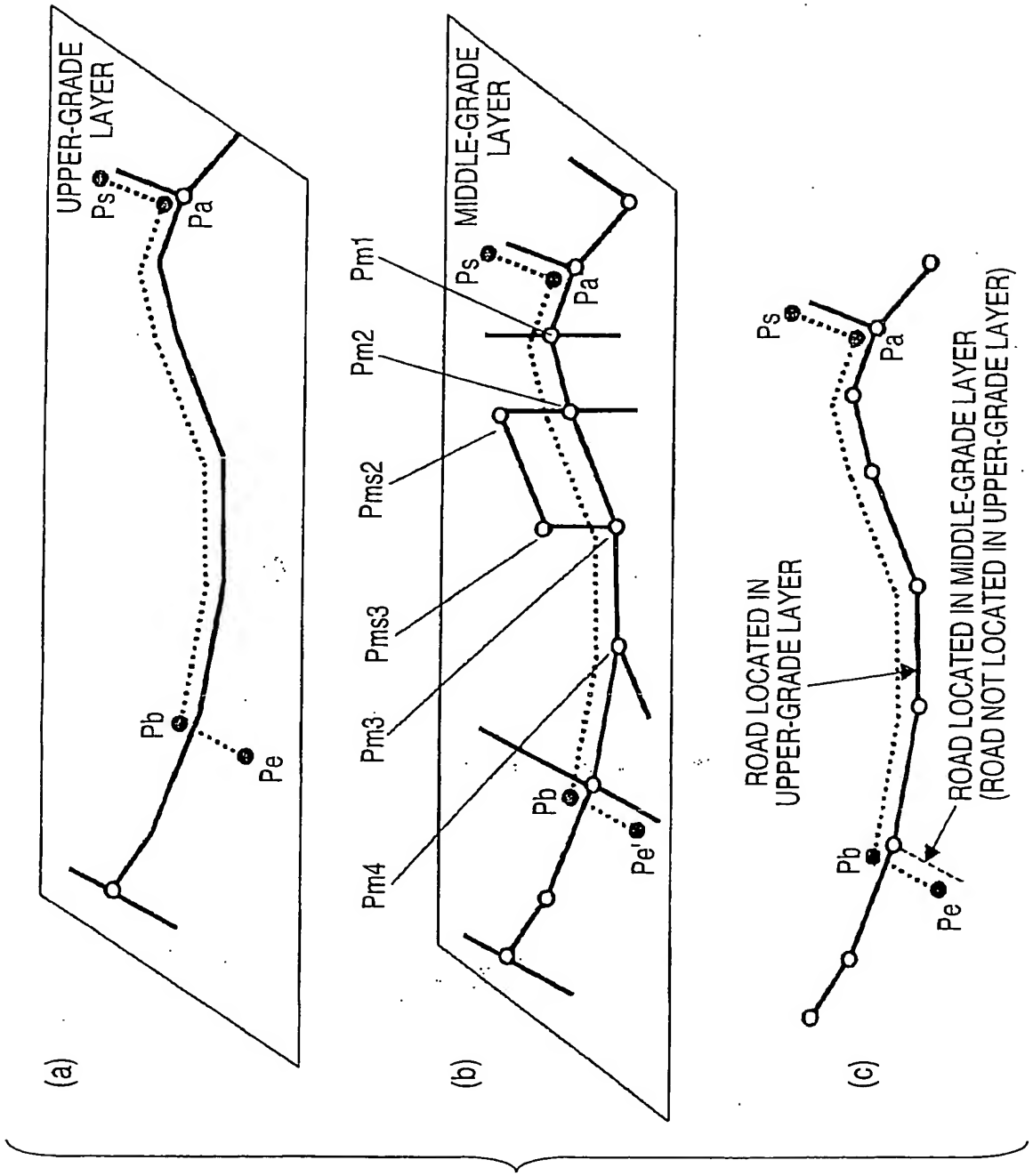
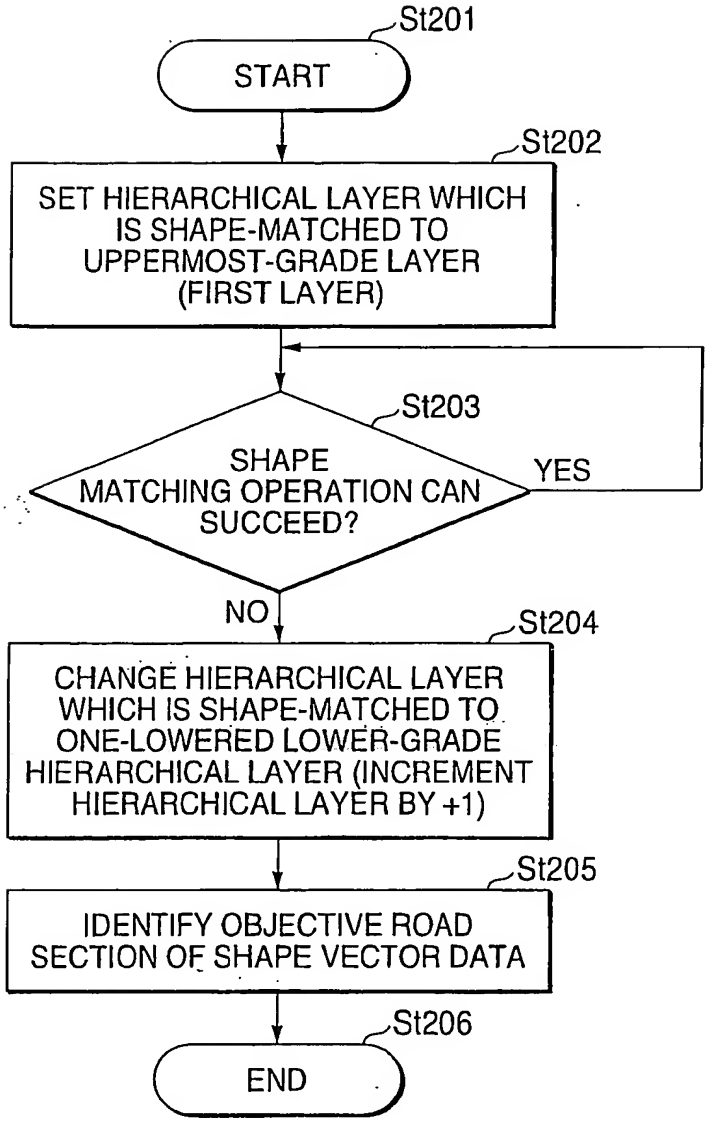

(a)
UPPER-GRADE LAYER
Ps
Pa
Pb
Pe
(b)
MIDDLE-GRADE LAYER
Pm1
Pm2
Pms2
Pms3
Pm3
Pm4
Ps
Pa
Pb
Pe'
(c)
ROAD LOCATED IN UPPER-GRADE LAYER
ROAD LOCATED IN MIDDLE-GRADE LAYER (ROAD NOT LOCATED IN UPPER-GRADE LAYER)
Ps
Pa
Pb
Pe

FIG. 49

FIG. 50


St201
START
St202
SET HIERARCHICAL LAYER WHICH IS SHAPE-MATCHED TO UPPERMOST-GRADE LAYER (FIRST LAYER)
St203
SHAPE MATCHING OPERATION CAN SUCCEED?
YES
NO
St204
CHANGE HIERARCHICAL LAYER WHICH IS SHAPE-MATCHED TO ONE-LOWERED LOWER-GRADE HIERARCHICAL LAYER (INCREMENT HIERARCHICAL LAYER BY +1)
St205
IDENTIFY OBJECTIVE ROAD SECTION OF SHAPE VECTOR DATA
St206
END

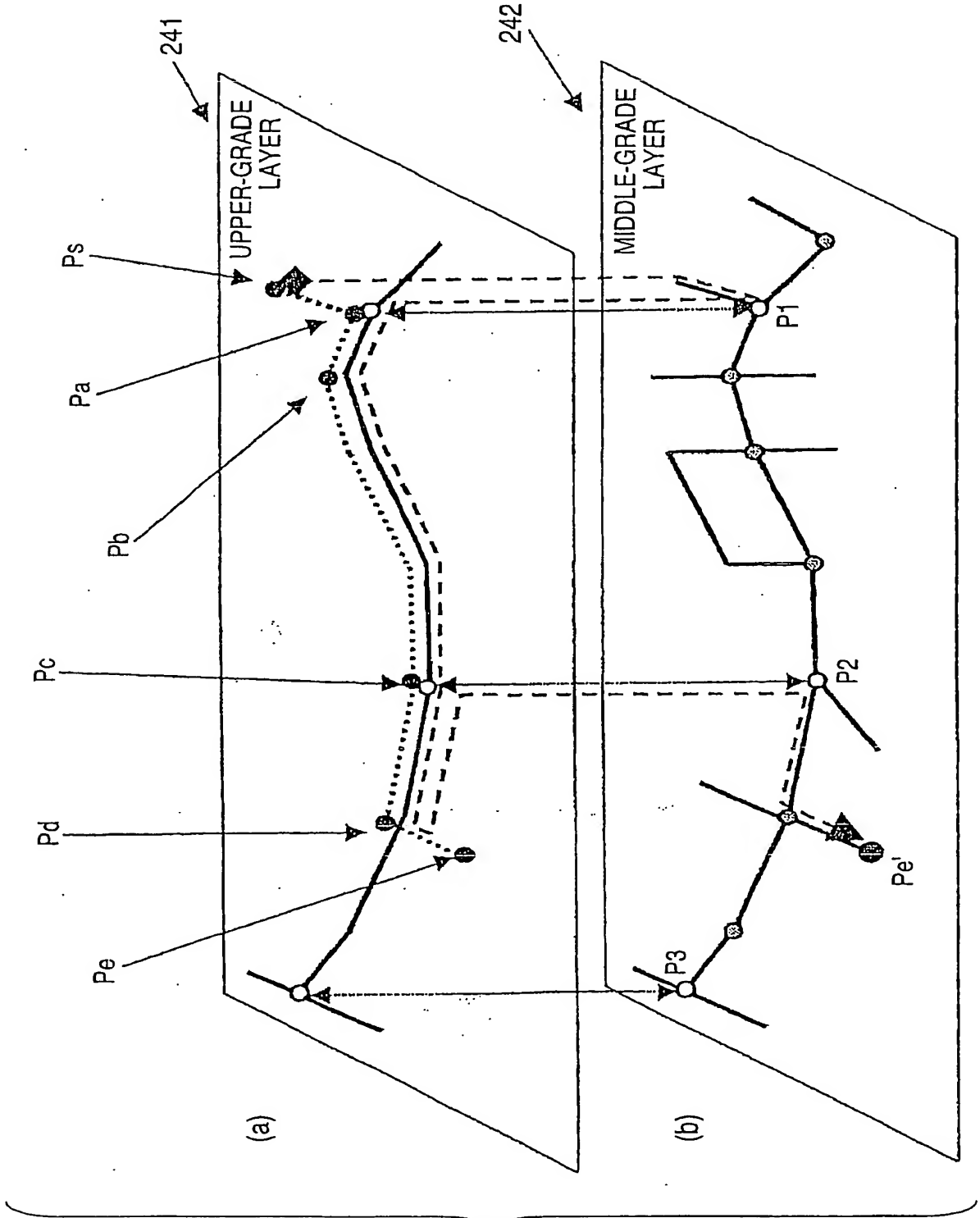

241
242
UPPER-GRADE LAYER
MIDDLE-GRADE LAYER
Ps
Pa
Pb
Pc
Pd
Pe
P1
P2
P3
Pe'
(a)
(b)

FIG. 51

FIG. 52

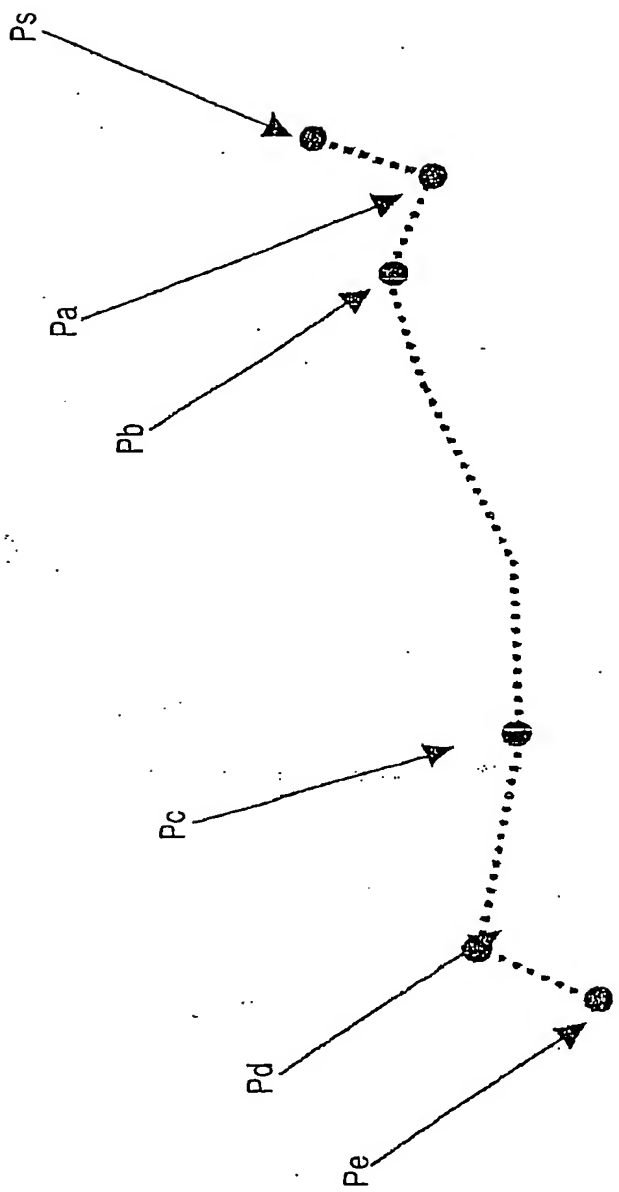
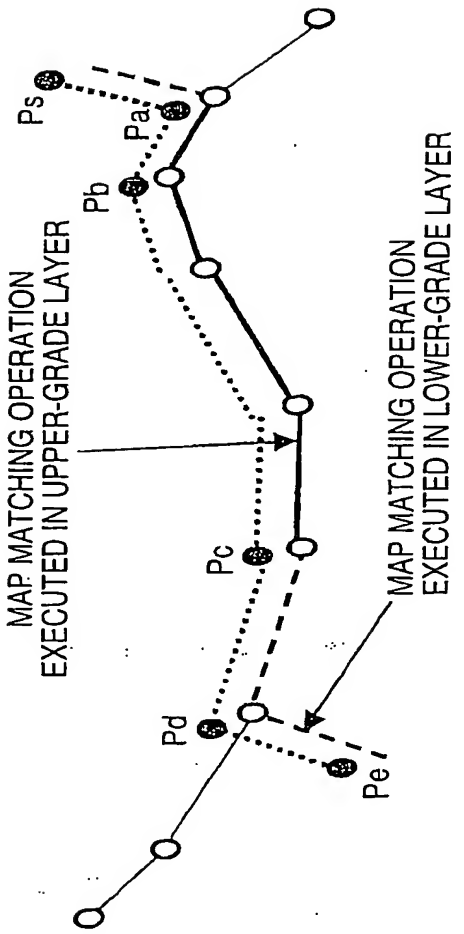

Ps
Pa
Pb
Pc
Pd
Pe
SHAPE VECTOR OF Ps→Pa→Pb→Pc→Pd→Pe
WHICH IS TO BE TRANSMITTED

FIG. 53


Ps
Pa
Pb
Pc
Pd
Pe
MAP MATCHING OPERATION EXECUTED IN UPPER-GRADE LAYER
MAP MATCHING OPERATION EXECUTED IN LOWER-GRADE LAYER

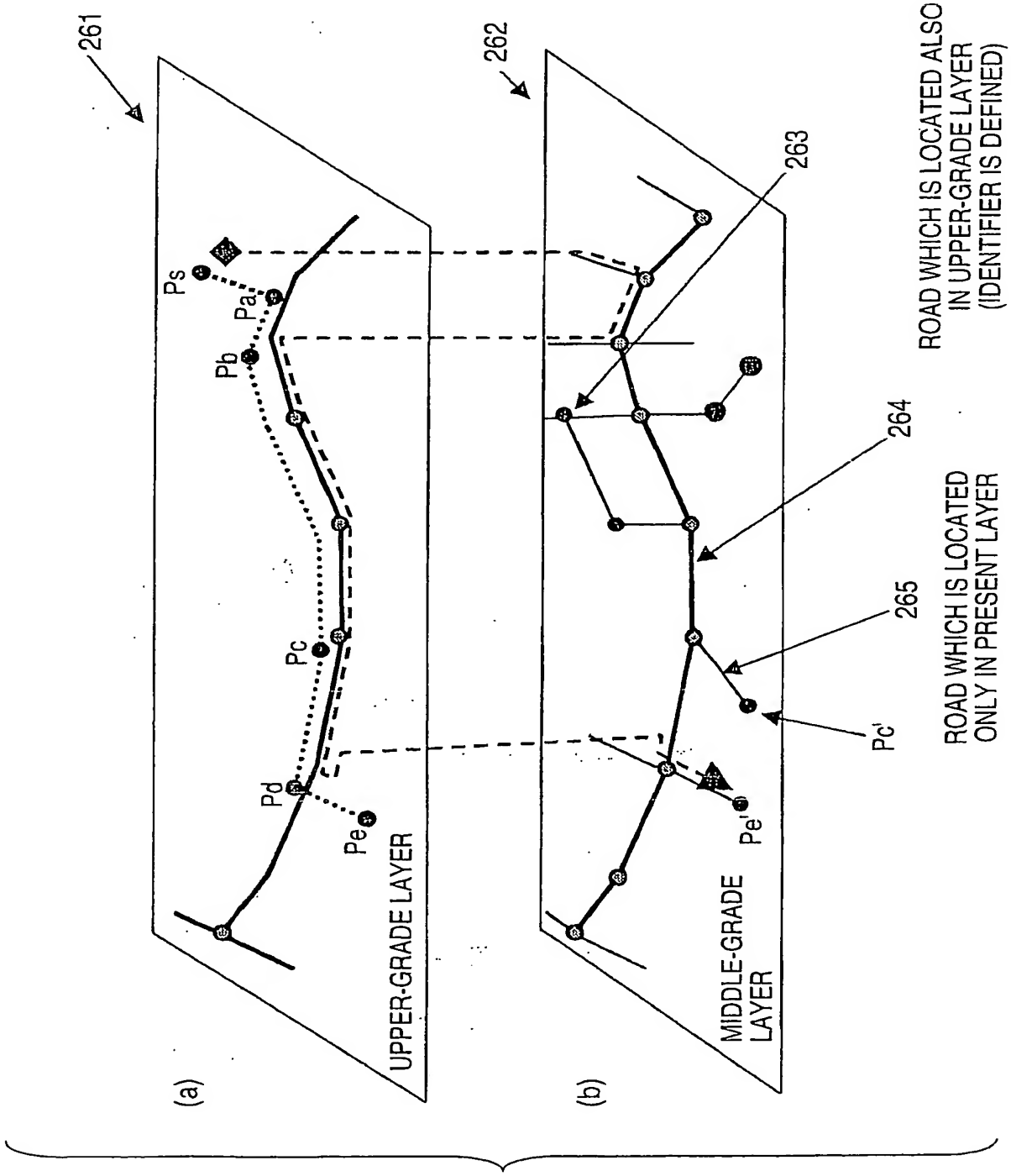

261
262
263
264
265
Ps
Pa
Pb
Pc
Pd
Pe
Pc'
Pe'
(a)
(b)
UPPER-GRADE LAYER
MIDDLE-GRADE LAYER
ROAD WHICH IS LOCATED ALSO IN UPPER-GRADE LAYER (IDENTIFIER IS DEFINED)
ROAD WHICH IS LOCATED ONLY IN PRESENT LAYER

FIG. 54

FIG. 55

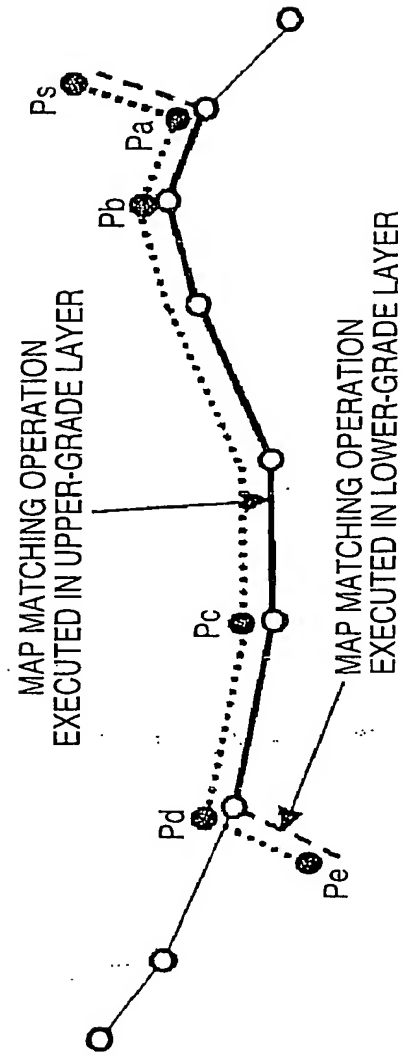

Ps
Pa
Pb
Pc
Pd
Pe
MAP MATCHING OPERATION EXECUTED IN UPPER-GRADE LAYER
MAP MATCHING OPERATION EXECUTED IN LOWER-GRADE LAYER

FIG. 56

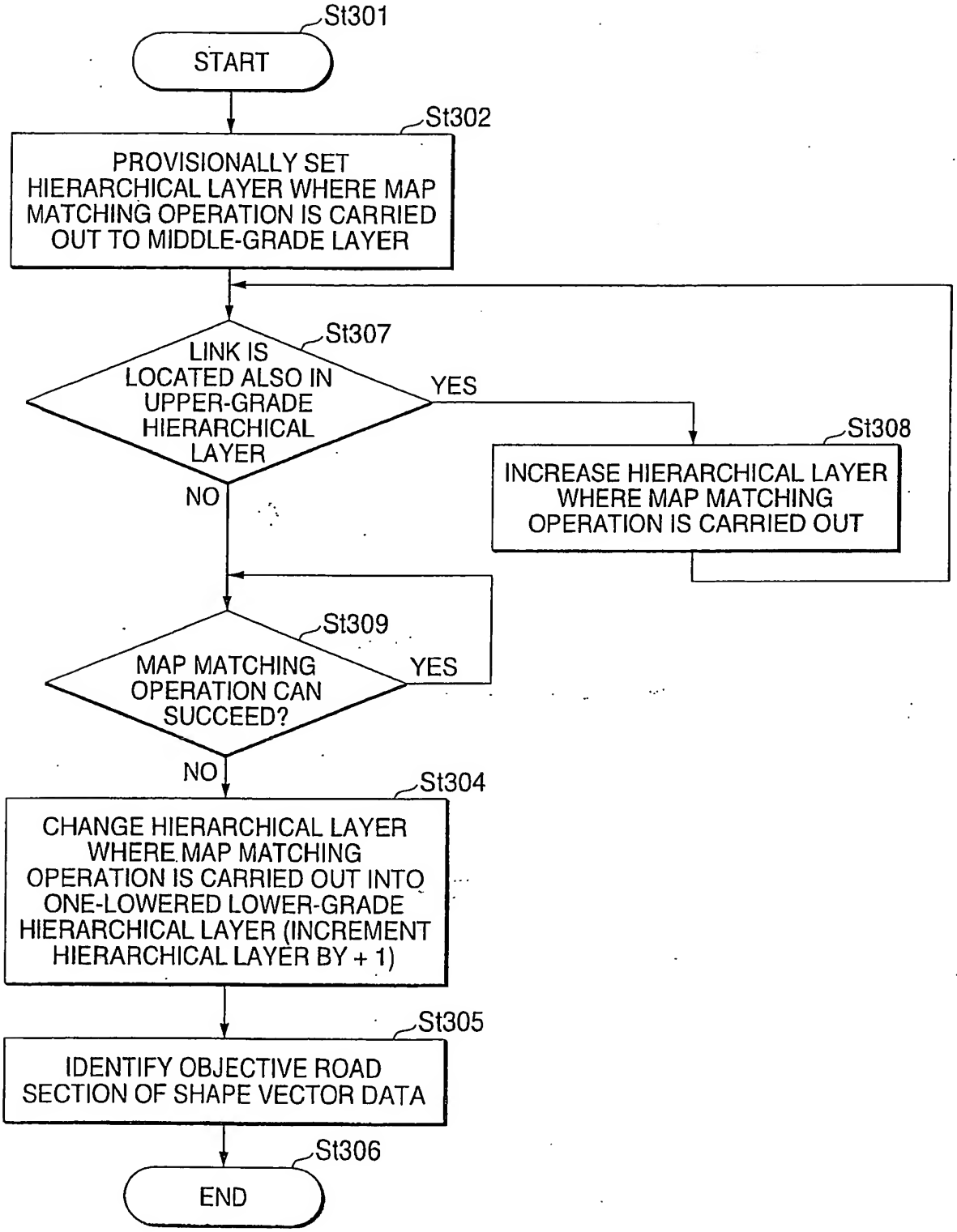

St301
START
St302
PROVISIONALLY SET HIERARCHICAL LAYER WHERE MAP MATCHING OPERATION IS CARRIED OUT TO MIDDLE-GRADE LAYER
St307
LINK IS LOCATED ALSO IN UPPER-GRADE HIERARCHICAL LAYER
YES
St308
INCREASE HIERARCHICAL LAYER WHERE MAP MATCHING OPERATION IS CARRIED OUT
NO
St309
MAP MATCHING OPERATION CAN SUCCEED?
YES
NO
St304
CHANGE HIERARCHICAL LAYER WHERE MAP MATCHING OPERATION IS CARRIED OUT INTO ONE-LOWERED LOWER-GRADE HIERARCHICAL LAYER (INCREMENT HIERARCHICAL LAYER BY + 1)
St305
IDENTIFY OBJECTIVE ROAD SECTION OF SHAPE VECTOR DATA
St306
END

FIG. 57

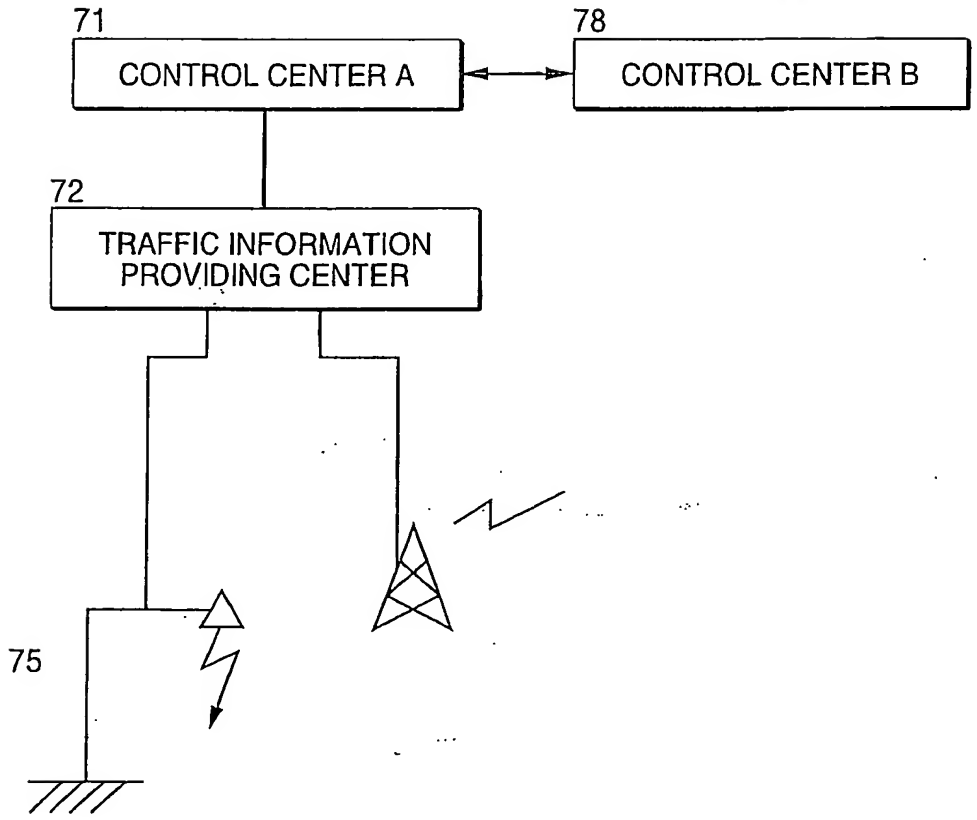
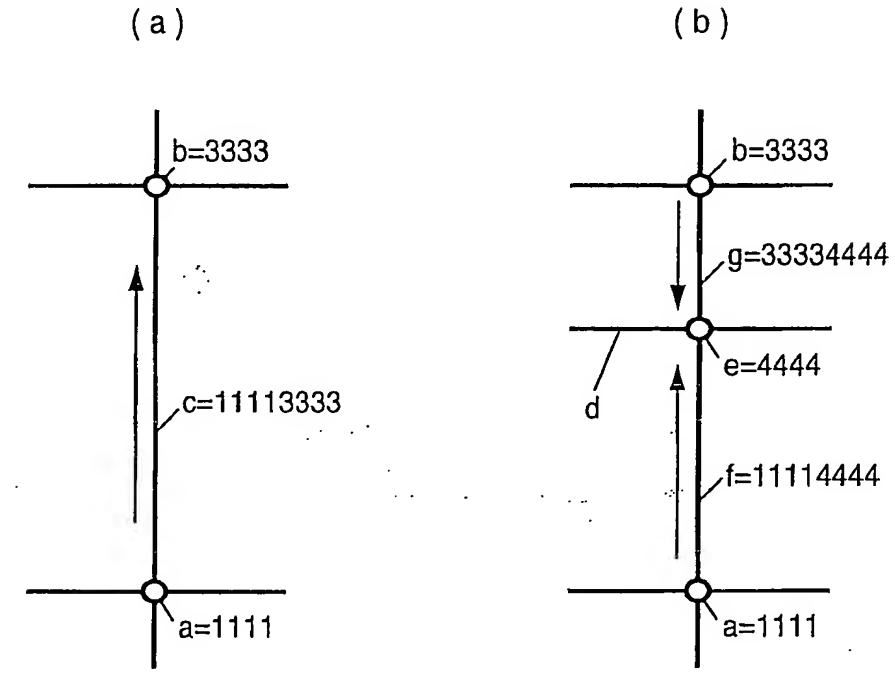

71
CONTROL CENTER A
78
CONTROL CENTER B
72
TRAFFIC INFORMATION PROVIDING CENTER
75

FIG. 58


(a)
b=3333
c=11113333
a=1111
(b)
b=3333
g=33334444
e=4444
d
f=11114444
a=1111